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Taking Stock in 1931

BY DR. KARL T. COMPTON

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THE entrance of a new class is always a significant occasion. No professor can predict what talent, genius and future power lie concealed and undeveloped in this new group of students. No student can predict what interest and opportunity may open up to him as the result of his work in and contact with the Institute. For both parties in the great adventure, student and teacher alike, there is that stimulating element of exploring the unknown.

In general, adventure and exploration involve hardship. The great rewards come as the result of hard work. It is the hard-fought athletic contest, and not the "walk-away" that holds interest and is remembered with a thrill. The human value in Admiral Byrd's voyage to the South Pole lies not in going so many miles, or traversing so much ice, but in overcoming hardship after hardship and attaining the goal. I have yet to meet a Tech graduate who does not still have a vivid impression of the difficulty of his course here, — and who does not feel proud of having made the grade. Sometimes I think we may overemphasize the difficulties of the course but, in any case, its value is certainly in some sort of direct ratio to the difficulty of its achievement.

My first word, therefore, is one of welcome to the new class, of greeting to the returning older classes, and of hope that all will make the best use of the opportunities here. This trite, time worn, obvious and unnecessary advice has a somewhat new significance just now, as follows:

The Spur of Competition

Competition always enhances the difference between excellence and mediocrity. In easy times all prosper with little effort and there is little incentive to strenuous improvement. In hard times the strong rise and the weak go under, and the urge to self preservation and success leads to extraordinary efforts. In hard times industries as well as individuals operate more efficiently. It has been said that the basis of success is always laid in times of adversity.

This country is now in a period of adversity. The world economic depression, the uncertainties of Russia and Germany and numerous other factors conspire in producing a prolonged period of unemployment and of retarded business tempo. In such a time it is doubly important for every man so to shape his course as best to survive this period and emerge with a firm basis of success. This statement applies to the student in several aspects:

1. Undergraduate achievement is at a premium. Employers are now much more careful than usual in employing young graduates. They cannot afford to make mistakes in choosing. They have relatively few positions open and the competition for these is keen. They examine closely the candidate's record of scholarship, reliability and personality and his record in extra-curricular activities. In general the outstanding men only get the choice positions.

2. There is a premium on postgraduate training. Obviously the more thorough is the training, the more valuable is the man, and hence the greater is his opportunity for securing an excellent position and making good in it. Furthermore men who, following graduation, would normally go to work but who fail to secure satisfactory positions, may well consider the advisability of going on with postgraduate work as a much better investment of time and effort than working at a job which offers little present interest or future promise.

3. A premium is placed on the best schools. In order to secure the best training and in order to be in the most favorable situation for getting and keeping in touch with positions, it is obviously advantageous to attend the school offering the best training and enjoying the highest reputation. In easy times this may not be so strikingly important, but in hard times its importance is emphasized.

The above elements of the situation have been so increasingly evident during the past few months and their significance is so plain that if any student should ask, "What should I do about it?" a sufficient answer should be "Here are the facts: let your intelligence be your guide!"

Unemployment May Create Engineering Jobs

Paradoxical as this statement seems, it is nevertheless probably true. The argument for it is this: Research, engineering practise and engineering administration are at the root of a large group of thriving newer industries, but have made relatively little impression on most industries, including many large ones like lumber, textiles, steel and other metals, coal, building, etc. Many of these, being based on exploit-

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The Chemical Identification of Solids by Crystallography

BY DR. M. J. BUERGER

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FEW chemists have had a sufficiently fundamental training to have more than a smattering of the so-called "special methods" of attacking chemical problems. Of these, still fewer have a knowledge of the existence of crystallographic means of identifying solid substances, and only a limited number of the chemists who have had their attentions drawn, accidentally, perhaps, to such unorthodox methods, have a true appreciation of them, of their value, or of how widely they are employed for chemical information in fields other than chemistry.

Technology students receiving instruction in optical identification of crystalline substances.

It is probably worth while pointing out that all sorts of identifications of chemical materials are made ultimately on the basis of some physical property measured or estimated under a specific set of appropriate conditions. In the usual, strictly chemical analysis, the ultimate identification is made on the basis of the physical property, solubility, and the conditions are arranged so that this property has a minimum value, *i.e.* as if a measurement of practically zero solubility were actually being taken.

The unique feature about the orthodox chemical identification is that it is made piecemeal, element by element, ion by ion, group by group. This is partly what entitles it to be called "*analysis*" and in this it differs from most of the other methods. Chemical methods of identification and most "special methods" thus compare with the alphabet and the idiograph manners of writing a spoken language, the ion by ion method being analogous to the letter by letter representation, and the identification of a substance, as such, in its entirety, analogous to the writing of a word by means of a single character. The analogy carries farther to some of the advantages and disadvantages of the two systems.

The alphabet and piecemeal methods are perfectly general and, just as any word may be spelled with the proper alphabet, in theory, at least, piecemeal analysis is capable of handling any case which might arise, given sufficient patience in seeing it through. As a matter of practical importance, however, it is best suited to the identification of the simpler compounds and often fails utterly as a routine method of analysis in the really complicated cases. Routine chemical methods are suited to such compounds as sodium chloride, potassium sulfate, and ammonium iodide, which are analogous to simple words like cat, train, etc. where the drawing of a conventional idiographic picture of each of these objects entails an amount of time at least equal to that required to write it sound by sound. On the other hand, the identification-by-the-whole methods are inflexible because they make use of effects too complicated to actually precalculate for any given substance with sufficient precision for real use. Hence they can only be used in cases where the effects have been premeasured on some of the same material; that is, they are empirical. In cases of very complicated substances, they may become very useful and time saving. For example, substances like alpha-amido-ethylidene succinic diethylester or methyltriethyl-ammonium mercuri-iodide can be crystallographically identified with complete certainty in about an hour's time. How long would it take the chemist to make identifications of these substances?

In order to fix attention on the general characteristics of the methods of analysis which aim to identify substances as a whole, a simple and specific illustration may be taken: the density of a substance is very accurately determined at 4° C. and found to be 1.0000 . . . grams per cc. If the substance is a pure compound it is not very difficult to arrive at the conclusion that it is water.

There is usually no certainty in an actual case of identification, however, that the substance at hand is a pure compound. It is quite possible, for example, to make up a solution of two miscible liquids, one whose density is higher than that of water and another with a density less than that of water, in such proportions that the resulting density of the solution is as near that of water under any given conditions as one pleases to make it. Density, however, will be the only measurable property which these two liquids will have in common, all other physical properties—viscosity, surface tension, refractive index, dispersion, absorption coefficients, etc. differing considerably from those of water, even when measured without any particular precision. This leads, without the necessity of any special proof, to the principle that any homogeneous substance is defined by the totality of all its properties; that, if two substances have all properties identical, they are by necessity the same substance; and that homogeneous substances of any kind whatever may be identified provided the proper-

ties have been previously measured and these data are conveniently available.

It is evidently not necessary to measure all properties of a substance to identify it. Indeed, since there is only a slight chance of any two given substances having even two measurable properties nearly the same, it follows that the measurement of about three representative properties serves to distinguish the unknown substance from practically all others.

There are two general classes of properties which it is convenient to measure on solid substances; geometrical and optical properties. Given appropriate conditions, a true solid compound may be made to assume an external crystal form bounded by plane faces. The geometry of the setting of these faces is characteristic of the substances and, with appropriate measurements, serves to identify it. When substances may be easily procured in good crystals, this method of identification is a very powerful one. On the other hand, optical properties may be measured on any bit of material regardless of perfection of external shape. Because of the fact that optical properties may thus be measured on any haphazard particle of the unknown solid substance, and because certain simple methods are available for very accurately measuring them, optical identification has been highly developed in non-chemical fields as an analytical method not only for the purest scientific research but for the most industrial purposes. The fields of mineralogy and petrography, and more recently, ceramics, make extensive use of optical methods.

Optical Methods of Identification

Practically all optical methods are concerned with a direct or indirect measurement of the index (or indices) of refraction of the unknown material. This particular property is measurable rather rapidly, and with such ease of manipulation, even for very small amounts of substance, that it has come to be a standard constant for the identification of crystalline substances. The following table gives the refractive indices of the alkali halides as an example of the differences to be expected in this constant for a series of chemically analagous compounds:

	Fluoride	*Chloride*	*Bromide*	*Iodide*
Lithium	1.392	1.662	1.784	1.955
Sodium	1.326	1.544	1.6412	1.775
Potassium	1.361	1.490	1.559	1.667
Rubidium	1.398	1.494	1.553	1.647
Caesium	1.578	1.6418	1.698	1.788

For purposes of identification, another table may be constructed by rearranging these values in the order of increasing refractive index:

1.326 NaF	1.6412 NaBr
1.361 KF	1.6418 CsCl
1.392 LiF	1.647 RbI
1.398 RbF	1.662 LiCl
1.490 KCl	1.667 KI
1.494 RbCl	1.698 CsBr
1.544 NaCl	1.775 NaI
1.553 RbBr	1.784 LiBr
1.559 KBr	1.788 CsI
1.578 CsF	1.955 LiI

Except for the bracketed pair of values, each value differs from the adjacent ones by .004 or more. Very simple methods of index determination can distinguish between such values. For optically distinguishing the two salts, NaBr and CsCl, whose refractive indices differ by only six units in the fourth decimal place, certain simple refinements in method are necessary. The qualitative plus quantitative analyses of any one of the salts in the foregoing list by formal chemical methods would necessitate a considerable expenditure of time, yet by optical methods this type of compound can be accurately identified in a time of, say, fifteen minutes.

While certain crystals, like the alkali halides listed above, have only one refractive index, the great majority of crystalline compounds display either two, or, in the more usual, general case, three refractive indices. Without going into the technical reasons for this feature here, it can be appreciated by its analogy with the several moments of inertia of a long, thin stick. The stick is easily twirled about its long axis, but offers considerable resistance to starting and stopping when an attempt is made to twirl it about a transverse axis. Likewise if a crystalline substance is composed of units ("unit cells") which are longer in one direction than in another (or differ in any way in various directions) light finds different eases of vibration in different directions in passing through the crystal, hence travels with different velocities as it vibrates in various directions, and therefore allows one to measure the different refractive indices corresponding with these vibration directions. Although the identification of a substance of this more complex type thus becomes more complicated, at the same time it becomes all the more certain, since, as explained previously, several substances may, by chance, have a single refractive index the same, to the precision of the measurement but the chance is very remote that any two substances will have all three of their refractive indices the same.

While the methods of determining a refractive index cannot be detailed here, it can be said that no direct measurements are made, but that the unknown is compared in a systematic and strategic way with a set of liquid standards. The actual instrument used in the testing and comparison is a compound microscope, but not the ordinary compound microscope. In order to separate the three refractive indices that most crystals display, a special type of microscope has been developed, known as the petrographic microscope, which makes use of polarized light. Certain microscopes known variously as "chemical micro-

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The two-circle goniometer, on which geometrical identification of crystalline substances is carried out.

The Hudson River Bridge

BY DONALD G. FINK '33

THE opening of the George Washington Bridge over the Hudson River between New York City and the New Jersey Palisades, which will take place this month, marks the completion of the longest single span suspension bridge in the world. Begun in 1927 by the Port of New York Authority, the construction has been completed several months ahead of schedule with resultant benefit to the congested traffic conditions which now exist between the States of New York and New Jersey.

By September, 1930, all work preparatory to laying the floor proper had been completed. Foundations and anchorages had been sunk, towers erected, and the four main cables spun.* Preparation of the cables for the suspension ropes was then begun, and the floor laid in less than a year. The floor and highway system presented several interesting problems, due to the extreme length of the span and the widely varying character of the land at each end. The problem of adequate approach facilities in the closely built area in upper New York City, made necessary a complicated system of ramps so that traffic could flow on and off the bridge without intersection of traffic lanes. With nearly 90% of the entire construction complete the bridge will be opened to traffic, since the remaining work can be completed without interference.

*The complete discussion of these phases of the work appears in "Construction Features of The Hudson River Bridge," TECH ENGINEERING NEWS, Oct. 1930, page 182.—*Editor.*

THE great public interest which has been aroused by the forthcoming opening of the Hudson River Bridge makes the appearance of this, the second article on its construction features to be published by THE TECH ENGINEERING NEWS, *particularly appropriate. The first article, by the same author, appeared in the October,* 1930 *issue, and discussed the construction work which had been completed at that time. The present article describes the work from that time to the completion of the structure this fall, so that the two articles constitute a detailed discussion of the entire construction. Though in a sense supplementary to the previous writing, the reader will find here a separate problem, that of the floor and highway system, fully discussed.* — Editor.

The New Jersey approach and side span, as viewed from the top of the Jersey tower. Note the construction of the steel floor and the diagonal bracing.

Construction Details — Compacting the Cables

After all the wire in each cable had been put in place, it was necessary to compact, or squeeze, each cable. This compacting process was performed in two operations, a preliminary light squeeze followed by a final one which brought the cable to its proper cross-section. The first was performed with a light compactor consisting of a hexagonal frame each side of which supported a hydraulic jack. A pressure of up to twenty tons was exerted by these jacks upon steel shoes which surrounded the wire of the cable. By applying this pressure at five foot intervals throughout the length of the cable, a uniform, and practically circular cross-section was secured.

The final compacting was performed by similar machines of much heavier design. Each consisted of twelve hydraulic jacks of 50 tons capacity, mounted on a frame and pressing against shoes which surrounded the cable. The hydraulic pumping was performed electrically. Applications of the compactor were made at from two to four foot intervals, thus squeezing the cable to its final diameter of thirty-six inches. A steel seizing band was fastened about the cable at each compactor application.

The cable was then ready for the cable bands, which consist of cast steel bands, in two halves, held in position about the cable by high-strength bolts. The friction between shoe and cable is sufficient to prevent sliding. Each band contains grooves over which the suspender ropes were passed.

Erection of the Suspension Ropes

The three-inch steel ropes which had supported the foot-bridges over which the cable was erected were then cut to the proper length for suspenders, socketed to fasten to the steel floor, and put in place on the cable over the cable bands. Cutting and socketing took place on the scene of operations at the top of each tower, approximately thirty-five miles of wire being thus cut to make the 592 suspenders. From the plant atop each tower the suspender ropes were slid to the proper position, and put in place, two over each cable band, so that at each suspension point there are four socketed ends. The suspenders nearest the towers were put in place first so that the work of erecting the steel floor could begin as soon as possible. With the suspenders in place, the only remaining work necessary on the cables was wrapping with wire, which was not started until the concrete deck on the main bridge was poured, when the greater part of the elongation of each cable had taken place. The wrapping will be complete at time of opening.

The Steel Floor Structure

When the suspender ropes nearest each tower

were in place, erection of the steel floor was begun. The design of the floor calls for two levels, an upper level of eight traffic lanes and two sidewalks, and a lower for four lines for rapid transit trains. Initially, only the upper level has been put in place, but the lower flooring will be put in place without serious interference with the operation of the bridge when the traffic volume demands it. The floor consists of main transverse beams spaced at sixty foot intervals, which are joined by eight smaller beams which run the length of the span. This framework supports lighter steelwork which will serve as the reinforcement for the concrete roadbed. Each main beam is hung directly on sixteen suspender ropes, four from each of the main cables. Stiffening is accomplished by means of cross laterals in panels formed by the main beams.

The floor steel lying within the tower was put in place first, after which two standard "A" travelers, each capable of handling a load of forty tons were assembled at the tower portals, and the main beams lifted by them to position directly from car-floats on the river. The two travelers worked together on each main floor beam (each beam weighs 65 tons), lifting it into position for fastening to the suspender ropes. The lighter steel was then erected by each traveler working independently. The main span, between the two towers, was thus erected in two months.

The erection of the side span flooring presented greater difficulties, since the steel could not be lifted from carfloats. The steel for these operations was lifted to the tower portals from the floats and then transported on trucks over the flooring already laid to the erection traveller which set them in place. Both side spans were complete on January 21, 1931, and the work of placing road and sidewalk commenced.

Traffic Studies

The Port Authority has been carrying out a series of traffic and revenue studies, before and during the progress of the construction, in order to determine the volume and direction of the traffic to be expected when the bridge is in operation. It has been found that the traffic from New York City to New Jersey in 1930 numbered 25,434,000 vehicles, a gain of eight percent over the previous year and nearly double that of 1924. Of this amount, ferries and the Holland tunnel can be expected to carry a large percentage, but it is expected that 10,000,000 vehicles will pass over the Bridge yearly within a few years after its opening. The traffic to be handled will be much larger than was anticipated prior to start of construction. This large traffic flow must be taken to and from the bridge as efficiently as possible, so that great care in the design of approaches was necessary.

Construction of the Approaches

The Palisades of New Jersey on one side and the thickly populated conditions in New York required widely dissimilar treatment in the matter of approach facilities. The New Jersey approach, due to the height of the cliffs and the sparsely populated area, is the simpler of the two. It consists of a broad plaza sunk below the surface of the rock, which connects directly with the bridge floor, little or no grading being necessary. Side ramps provide connection with the highways parallel to the river, while further away the plaza widens into several different lanes which connect directly with the state road system of New Jersey.

The New York approach was designed to meet the following conditions: direct connection with Riverside Drive and Broadway, direct cross-island traffic to the Harlem River, connection with all streets between Riverside Drive and Broadway, and no intersection of traffic lanes. Since Riverside Drive lies below the level of the bridge floor, the problem of conducting traffic on and off, both from the north and the south, without traffic intersections, was a difficult one. From the main bridge floor, a graded ramp slopes down, is carried over the Drive on an arch 196 feet long, attains street level, and widens into a plaza which opens

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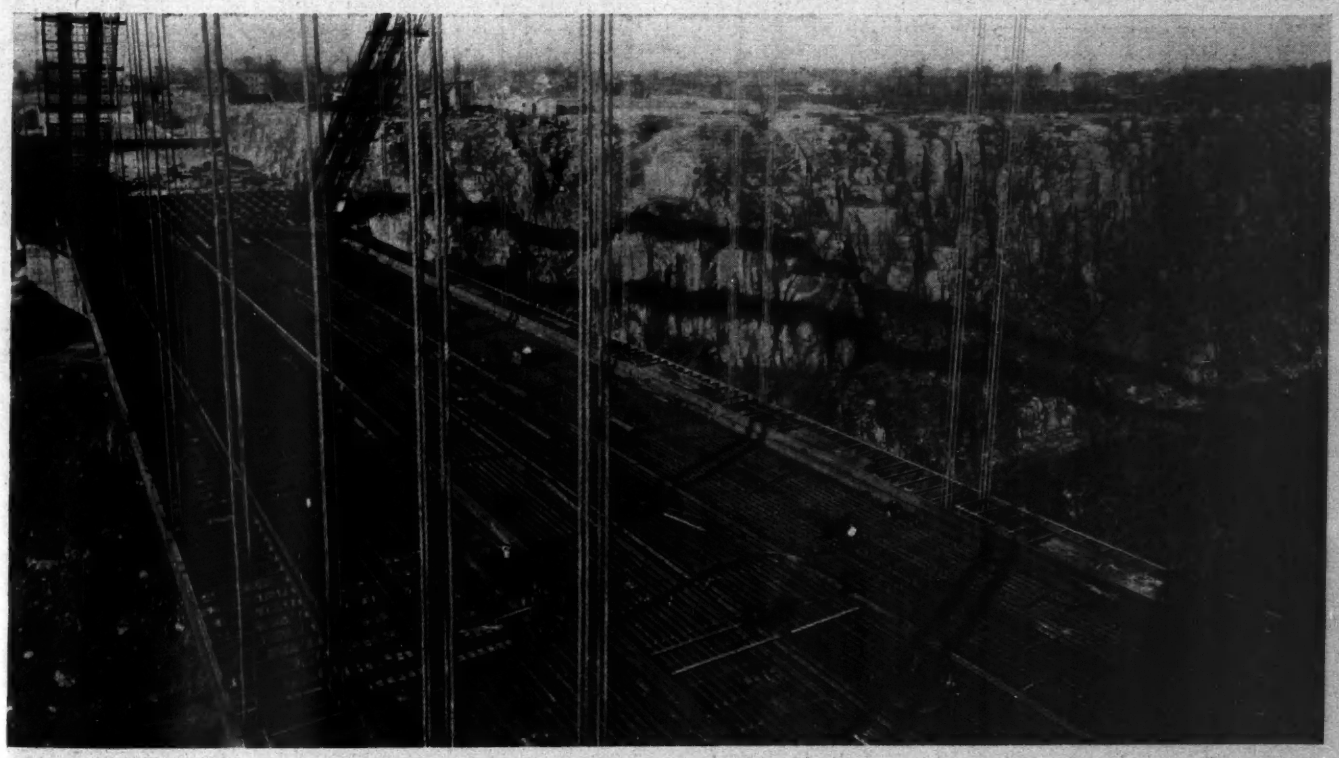

New Jersey side span floor steel, showing method of suspension. The three roadways can be clearly seen in the steelwork.

Glass Bottle Manufacture

BY CHARLES T. STEWART '34

THERE appears to be no authentic record of the date when, where, or by whom the art of glass making was discovered. We do know that glass has been made by lightning striking at the edge of a sand pit, so that the making of glass is of ancient origin. We also know that glass beads were found in the tombs of the rulers of the First Egyptian Dynasty, 5000 B.C. It is a curious fact that the first glass containers were tear bottles for tear drops. These were found in the tombs of the later Pharaohs of about 4700 B.C. Next, about 4000 B.C., wine bottles were made. There are specimens of glass articles of many artistic designs in both British and American museums which bear undisputed evidence of having been made hundreds and probably thousands of years before the birth of Christ. The Egyptians and the Greeks seem to be the first people of whom we have any record that manufactured glassware successfully, but it was the Venetians who, at a very early date, became famous for their skillful designs and decorations of glass articles. Their reputation in this particular field is still unsurpassed.

Next in importance and skill to the Venetians were the Bohemians who made a specialty of artistically engraved ware which soon became celebrated. In these early days, all articles of glassware were used only as luxuries and by those who were of noble birth or in possession of great wealth.

The first glass works in this country of which we find any record was established about the year 1750, when one was built in the state of Massachusetts, and destroyed by fire during the Revolutionary War.

Beginning about the year 1820 and for twenty or thirty years thereafter, glass works were constructed in the states of Massachusetts, New York, New Jersey, and Pennsylvania. Pittsburgh and its immediate vicinity became the principal glass producing territory in the United States, remaining so until about the time natural gas was discovered in Ohio and Indiana. Due to the comparatively low cost of the fuel, many glass producers moved their plants to Ohio, Indiana, and Illinois making these States now the largest glass producing states in the country.

New Furnaces Introduced

There was not much development in the manner and methods of making and working glass until within the last thirty or forty years, when the first Continuous Regenerative Tank Furnace was built in this country. This furnace was constructed largely along the lines of a patent issued by the German government to a man named Siemens. The special features claimed for it were the utilization of waste heat, and providing a method for continuously working and melting the glass, thus increasing production over the former method of melting in pots during the night and working during the following day which had been the custom for many years previous.

The installation, of the continuous tanks seems to have been the beginning of the introduction of more modern methods of manufacturing glass not only by hand, but by substituting machines for hand labor. The material used in the construction of the tank, especially that part that comes in direct contact with the fire, is the best of fire clay made into solid blocks about 12 or 14 inches in thickness and about the same in width, and from 30 to 36 inches long. These are laid up with broken joints, to the proper height, while the bottom blocks are supported by heavy I-beams resting upon a solid foundation.

The crown or cap of the furnace is made of pure silicate brick generally 4 x 8 x 12 or 14 inches, the length of the brick constituting the thickness of the crown. These bricks are capable of resisting great heat and often last through three or four blasts of ten months each without having to be replaced while many of the flux line blocks have to be replaced at the end of each blast.

The working end of the tank is separated from the melting, and by a bridge composed of two separate walls, about 18 inches apart, covered by fire clay blocks immediately above the glass line. Near the bottom of the bridge is a small opening which connects the two compartments and through which the glass passes from the melting into the working end, where it finds its own level. When the tank is filled, the melted glass therein is from 30 to 36 inches deep, depending on the tank.

Around the working end, circular in form, is a series of "Ring-holes" through which the blowers gather the glass upon the end of a blow pipe. On both sides of the melting end are constructed regenerators filled with fire clay tile blocks, laid in checker style, for the admission and difusion of the producer gas and air which are kept separate from each other by a partition wall until they reach the top when they are united in proportions to let the gas ignite just before entering the tank.

Immediately under the tank is provided plenty of space for the circulation of air, for the protection of the bottom blocks, and for the purpose of confining the melted glass should an accident occur to the tank causing it to run out.

Some distance from the tank are located the gas producers, in which is made the gas that operates the tank. The gas is conveyed to the regenerators through tunnels under ground or through heavy iron tubes, usually above ground, and lined with fire brick. In the tunnel or tube is located a large valve for the purpose of reversing the gas from one side to the other, a process which is repeated every thirty minutes both night and day while the furnace is being operated.

A large tall stack is also connected with the regenerators by a tunnel underground with the draft to it being regulated by dampers on both sides of the tank. The heat and fumes arising from the melting batch are drawn across into ports on the opposite side of the tank, then down through the regenerators into the tunnel and out through the stack. By this means, the regenerators are kept hot and provide an efficient means for heating both air and gas before they enter the tank.

In heating a new tank preparatory to melting glass, much care must be exercised to prevent the bursting of the blocks, or the spreading of the tank by expansion due to the great heat. To avoid an accident of this kind, a slow drying fire is started, usually with crude oil, by introducing it through burners at the bottom of the regenerators and gra-

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The Engineer's Place in Public Utilities

BY THOMAS E. PENARD '00

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IN speaking of the engineer's place in Public Utilities I naturally have in mind the Electric Light and Power Industry in particular. The same remarks, however, except in specific details, apply equally well to other Public Utilities such as the Railways and Telephone. All are essentially engineering projects whose very existence is dependent upon the art of engineering. The engineer has played a prominent and invaluable role in their inception and struggles for existence and his services in their further development are as indispensable today as they were in the trying days of their modest beginnings.

The phenomenal growth from small companies with a small crew of workers to large corporations employing thousands of men and women to care for the enormous amount of detail incidental and necessary to carrying on the business has tended somewhat to obscure the engineer as a personal element. Nevertheless, he is as much a factor today as he was in those early days when aside from his work as an engineer he had thrust upon him many other duties not necessarily of a technical nature.

The engineer has the same opportunity as others to reach and occupy executive positions. His engineering training is an aid rather than a barrier to their attainment. Many executives of our Public Utilities have come from the engineering ranks. My remarks, however, will be confined to the engineer as a technical factor in the organizations of these companies.

The purely engineering activities of a Public Utility Company arrange themselves naturally into five major divisions; viz.: (1) Planning, (2) Design and Construction, (3) Operation, (4) Commercial Engineering, and (5) Research. The organizations of operating companies differ widely in their set-up and may not conform outwardly to this classification, but the character of engineering work in the various departments is generally such as to fall readily under one or another of these divisions.

Planning

In this division are the planning engineers who maintain records of loading conditions and physical plants in sufficient detail to enable them to plan intelligently. On these engineers rests the responsibility of guiding the development of the system along lines of minimum investment consistent with good service and reasonable operating losses. They forecast the requirements with respect to ability to serve the expected load and determine methods of transmission and distribution, and the economic steps to be taken toward the desired end. Such work must be in advance of immediate needs, sometimes to the extent of five or even ten years, and involves considerable study in the trends of load growth as indicated by past experience and the tendencies of the times.

Design and Construction

The scope of work under this heading includes extensions to plants to meet normal growth and special requirements, and the remodelling of existing installations to effect greater economy made possible by advances in the art. It is the work of the engineers in this group to study the means of accomplishing the desired results, not only taking into consideration the physical elements but giving careful attention to the economics of first cost and subsequent operation, the reliability of equipment and installation, and matters pertaining to safety. The work may be divided into three groups, (1) design and engineering, (2) drafting, and (3) field work.

In the first group we find the engineers responsible for correct design, who work out the lines to be followed, select the proper equipment and materials, and prepare the necessary specifications. Here the technical engineer finds scope for his initiative and genius and the application of the theoretical principles which are a part of his training, tempered, of course, by practical considerations and common sense gained from experience with actual installations. Smaller companies who do not carry on their staffs trained engineers for this work must do the next best thing and thus depend largely upon the engineers of manufacturing concerns for advice of this nature, or resort to consulting engineering firms. It is obvious that the most satisfactory results are obtained from the work of engineers of an operating company who are familiar with its needs and whose experience with different makes of apparatus in service frequently gives them an advantage. Of course, it is desirable to cooperate fully with the manufacturers in order that the designs of their products may meet the special requirements, if any, or to give them the benefit of operating experience as a result of which improvements may be made.

In the second group we have the engineer draftsmen who lay out the work conceived by the design engineers and under whose supervision other draftsmen with engineering training or knowledge work up the details.

In the third group are the field engineers who carry out the plans and specifications of the office engineers. They devise methods for the proper and efficient execution of the work, coordinate the various parts to avoid confusion, and expedite the progress to meet dates of partial or final completion. These are the duties of the production engineers under whose direction the inspectors, contractors, and other workmen act directly or indirectly.

Operation

This major division comprises two groups; viz.: (1) Operating and (2) Maintenance.

It is the work of engineers of the first group to operate the plant in the most efficient and economical manner. To this end they study the various load conditions, prepare daily and seasonal schedules, make inspections and tests as necessary, and, in general, watch continually over the entire system, giving careful attention to every detail in order to forestall

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The PRESIDENT HOOVER. This is the first liner built in this country for trans-ocean service.

Courtesy General Electric Review

Turbine Electric Ship Propulsion

BY FRANK V. SMITH

Federal and Marine Department, General Electric Company

THE fireboats *S.S. Joseph Medill* and *S.S. Graeme Stewart*, built for Chicago and launched in 1908, were the first ships in the world to adopt turbine electric propulsion. They are still in commission after twenty-three years of service. The power plants on these boats consist of two turbine generators of the direct current type and the fire pumps are placed on extensions of the generator shafts. In this way the main power plants are made to serve two purposes.

The first ship to utilize turbine electric drive with alternating current machinery was the U. S. Naval Collier *Jupiter*, which was commissioned in 1913 and later converted into an airplane carrier and renamed the *Langley*. This ship demonstrated the practicability of the system for large ocean going vessels, and in turn became the forerunner of the large electrification program carried out by the U. S. Navy on its battleship fleet. The battleship *New Mexico* was commissioned in 1918, and in the years 1921 and 1922 followed the *California*, *Colorado*, *Tennessee*, *Maryland* and *West Virginia*. The airplane carriers *Saratoga* and *Lexington*, turbine electrically propelled and the highest powered vessels in the world, were commissioned in 1927.

The application of turbine electric drive to merchant ships may be said to have had its first impetus in 1928 upon the completion of the passenger liner *S.S. California*. Although prior to 1927 there was a total installed horsepower of 222,800, 86 per cent or 191,800 horsepower was in connection with Naval and Coast Guard vessels. Of the 31,000 horsepower installed on merchant ships, 15,000 horsepower were installed on five cargo boats contracted for as part of the war building program, 9000 horsepower on harbor ferries and the balance on four ships of miscellaneous type.

Merchant Ships Adopt System

Since 1927, a total of 770,100 horsepower of turbine electric propelling equipment has been built, of which 390,000 horsepower have been installed on Naval and Coast Guard vessels, and 380,100 horsepower on merchant ships.

The reasons for electrifying a merchant ship are somewhat different than for a naval vessel. One of the requisites of a naval vessel is "wide cruising radius" at reduced speed, which in turn may be interpreted into the need for high efficiency at low powers. On the other hand, the large passenger vessel operating on schedule usually travels at its normal full power rating almost continuously and high efficiency at that point, therefore, becomes of primary importance.

Turbine electric drive is a versatile form of propulsion from a design point of view and once the facts are known in relation to the service requirements, may be designed to best meet the needs of that service. The factors which enter into the problem of ship powering consist of the ship type, schedule speeds between ports of call, the auxiliary power needs, and fuel costs at ports of call. To best meet the specific needs of a given vessel the application engineer has at his disposal various types of alternating current motors, a fairly wide choice of turbine speeds and the number of poles on the motor, several different methods of supplying auxiliary power, a free choice of the initial steam conditions, and the privilege of including series feed water heating by the extraction method, etc.

Each ship becomes a study in itself, and although high efficiency could be obtained on almost all jobs, the solution to the problem must always rest on the side of economy, which means an evaluation of first costs versus efficiency. In marine engineering application departments it is general practice to make several analyses of each proposed installation and to evaluate each factor entering into the problem of overall economy on its own merits.

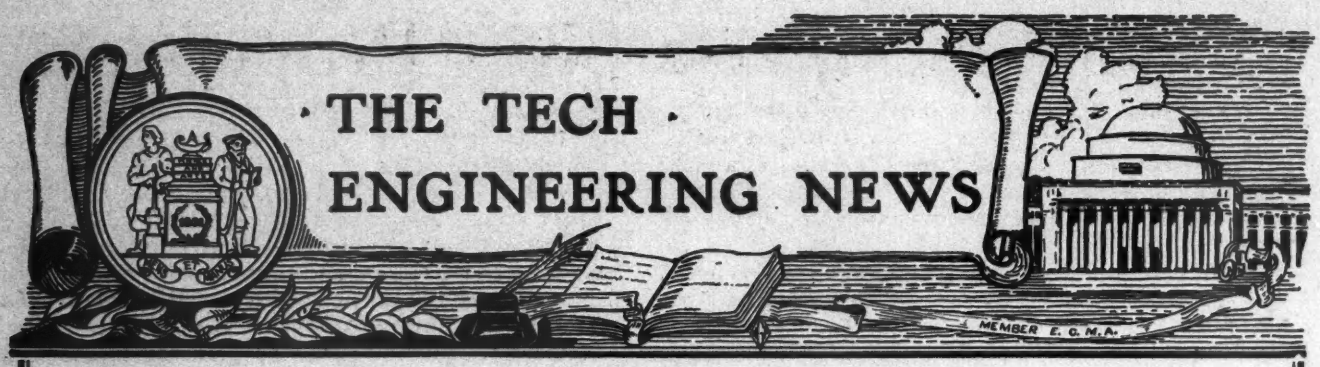
Types of Motors

The type of propulsion motor used resolves itself down to a study of the ship's power needs in service and a consideration of the auxiliary power requirements. Two types of motors are used—the induction type and the synchronous-induction type. The primary difference between the two is in the method by which the rotor or field windings are excited. In the induction type of motor the rotor revolves at a slightly lower speed (approximately 1 per cent) than the revolving flux in the stator, thereby cutting magnetic lines of force which causes a current to flow in the rotor windings. In the synchronous-induction type of motor, the induction windings are used in starting only, and as soon as the rotor reaches its slip speed as an induction motor, excitation is supplied to the rotor windings from an outside source.

In large Naval applications the chief advantage of the induction motor is that this type of motor may be wound for different pole combinations, thus giving a change in the speed relationship between the turbine generator and propelling motor. At low powers and speeds this permits of an increased turbine speed with more efficient operation, therefore of an increased cruising radius with a given amount of fuel. In the battleship installations the stators of the induction motors were wound for either 24 or 36 pole connections, and in the airplane carriers *Lexington* and *Saratoga* for 22 and 44 poles.

The induction motor is also used when it is found desirable to furnish power from the main generators for auxiliary purposes, because it can be phased in at relatively high generator speeds or near normal frequency. In the self-unloading bulk freight carriers *T. W. Robinson* and *Carl D. Bradley*, which operate on the Great Lakes, there was a simultaneous need for power to drive the unloading equipment and propulsion. This was met by using the slip ring type of induction motor, or wound rotor type, and attaining low propeller revolutions by inserting resistance into the rotor windings, without altering the frequency and, therefore, the speed of the auxiliaries. The slip ring type of induction motor was also used on the yachts *Corsair* and *Viking* in order that power could be obtained from the main generators for auxiliary

(*Continued on page 178*)



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Editorials

Welcome!

To you, freshmen and transfers, who are just entering Technology, THE TECH ENGINEERING NEWS extends a hearty welcome. We believe that your years at Tech will prove pleasant as well as profitable and hope that you will be able to take full advantage of the opportunities which abound here.

Undoubtedly a certain number of you will be interested in extra-curricular activities. May we suggest that THE TECH ENGINEERING NEWS offers excellent opportunities for participation in these activities as well as giving valuable experience in magazine assembly.

It is the policy of this magazine to present articles which in the aggregate cover the various fields of engineering. It is our aim to obtain material which shall be authoritative, written by authors who understand their subjects, and still of such a nature as to be understandable and interesting to students who may not be pursuing the special fields of which the articles treat.

There is also opportunity for student articles of worth which are well written and carefully worked up. We hope that by publishing a number of chosen student articles, habits of careful workmanship and clear, concise presentation may be encouraged. For members of the staff there is especially good opportunity for practice in writing.

Again, may we urge that anyone interested in gaining valuable publication experience as well as participating in a live activity, come out for THE TECH ENGINEERING NEWS.

"A Scholar and a Gentleman"

"A Scholar and a Gentleman."

That phrase, simple but expressive, has long stood for the highest type of manhood, and has been the finest compliment which could be paid a man.

"Scholar," as used here, does not denote the narrow-chested, anaemic, stoop-shouldered individual who constantly keeps his nose buried in a book and is oblivious to all his surroundings. It denotes, rather, the inquiring, open-minded searcher after truth, the man who observes and analyzes not only everything he reads, but also everything he sees, the many small and great incidents which come under his daily observation, the actions and opinions of his fellows. He weighs what he sees and hears, and comes to an independent judgment after careful and impartial thought.

Such a man is inevitably one whose interests range over a great many fields, who does not confine himself to one narrow specialty, but who has a wide understanding of all the factors which make up our mode of living and which influence our progress. His is the

type of knowledge which begets wisdom, that tolerant, common-sense wisdom which is the mark of a truly great mind.

"Gentleman," again, does not indicate the suave, polished, very polite personage who is dressed in the height of fashion, and can turn a pretty phrase of speech to fit each occasion, but who is, taken altogether, shallow and incapable of coming up to any real test.

As used here, "Gentleman," to be sure, presupposes that a man is courteous, considerate, has manners which are not offensive, and observes those customs which make his presence pleasant to others. He is far more than mere pleasant company, however. He has a broad sympathy with human beings in general, understands human nature with all its good points and failings, realizes it is not perfect, but does what he can to encourage the better impulses of his fellows. His is a many-sided personality which can meet and understand different types of people without clashing.

The world is always in need of executives who measure up to this standard. The executive must constantly make decisions which involve the work and environment of others. If he administers his position of responsibility in such a fashion that it increases the well-being and happiness of those under him, he is doing much to improve the community and to aid progress.

There is an aspect of this which is of especial interest to the coming engineer. Our civilization, due to the activity of scientists and engineers, is becoming intricately complex and highly technical. As a result, it is becoming necessary to place more technically trained men in administrative positions. Only men with a thorough understanding of the mechanical bases of our era will be able intelligently to guide and direct it in the future. At the same time, these positions will continue to demand of their incumbents that they be individuals of the highest type.

The challenge to the young engineer is plain. If he would attain high places it is up to him to perfect himself in his branch of engineering so that when the time comes, his capabilities will entitle him to responsible positions. He must at the same time broaden his outlook to extend much farther than the limits of his own field, he must cultivate habits of clear thought, observation, and cool judgment, and he must above all cultivate an understanding of and sympathy with humankind and its problems. It has been said that the world is in crying need of philosopher engineers. May they, for their own and the world's benefit, prove also to be "Scholars and Gentlemen."

A Way Out

It is a recognized fact in educational circles that universal education, like all democratic institutions, tends to keep all students at a level — excellent for those who naturally fall below that level — but extremely apt to blunt the keen, inquiring edge of those minds which are above the average. There is no stimulus to such minds to keep on the alert and they are only too likely to lose their capacity for real effort.

Therefore, while our present deadly uniform educational system remains what it is, the gifted student must use his own ingenuity to further his education as he desires. The drawback may become an incentive to independent action and a training in self-reliance in pursuing on his own subjects which are fascinating to him. Research, outside reading, and outside study in pursuit of further information relating to his field, would keep an inquisitive mind on the alert.

There is a limit to which anyone can go in any technical subject without guidance. Perhaps the best use, therefore, to which extra time resulting from a slow-moving class could be put, would be in reading in fields outside of engineering subjects—literature, philosophy, history, — any one or several of dozens of subjects which would widen anyone's outlook and prove a constant source of delight to a keen mind as well as keeping it constantly on the alert to follow the ideas of the great writers of the past and present.

While this program is undoubtedly a poor substitute for a carefully planned manner of teaching flexible enough to allow the gifted student to proceed as rapidly as his own capacities would allow, it is still one way out for the bedeviled and overlooked superior student.

Staff Change

The Managing Board announces the appointment of Mr. Wilber B. Huston '33 to the position of Advertising Manager, a position left vacant by the resignation of Mr. Edmund H. Lloyd '33. Mr. Edward L. Jones '33, former Features Editor, has been appointed Associate Editor.

Sir Isaac Newton

1642–1727

England's first great man of science had a very smooth-flowing and successful life, living to receive honors from all sides for his enormous contributions to man's store of knowledge. In his early school days he showed an attachment to mechanical pursuits, making kites, windmills, a water clock, and a carriage for his use. At eighteen he entered Trinity College, Cambridge, where he was to do so much of his splendid work. The purchase of a prism led him to study the theories of color and of light. Later discoveries proved useful to him in constructing the first reflecting telescopes. Newton first showed that light consists of rays, some of which are more refrangible than others. His text on "Opticks," published in 1704, discussed the colors of transparent plates, explained opacity, transparency, and colors, stated the laws of double refraction and of the polarization of light, and gave his completed theories of light and optics. Newton regarded light as a peculiar substance composed of heterogeneous particles thrown off with great velocity, and in all directions, from luminous bodies, which theory has recently secured many new supporters.

Everyone knows the tale of the falling apple, which brought the force of gravity to Newton's attention. Reflecting upon its cause and effects, he considered the effect of gravity on the moon and after laborious calculations which were delayed at first because of errors, he deduced from the motions of the moon and from Kepler's three great laws his principle of universal gravitation. This led him to the true cause for planetary motions, which he explained in his "Principles of Natural Philosophy" in 1687, showing why the earth is an oblate spheroid and why the intensity of gravity changes in going toward the equator. His discoveries were assailed and resisted, and the Cartesian system was preferred, but the Newtonian philosophy was gradually accepted in Great Britain so that long before his death Newton enjoyed the satisfaction of seeing his own philosophy triumphant in his native land, a joy granted to few men.

In mathematics, Newton worked on infinite quantities, discovered the binominal theorem, solved problems stated by Bernouilli and Leibnitz, and preceded Leibnitz in the discovery of calculus. He made minor discoveries of importance in chemical research and used his knowledge of light in designing several new scientific instruments. His public life included holding a seat in Parliament, and the position of Master of the Mint and of President of the Royal Society, which latter position he held for the last twenty-four years of his life. He was knighted by Queen Anne in 1705. Another side of the man is revealed by his important theological studies and publications. "By uniting philosophy with religion, he dissolved the league which genius had formed with scepticism."

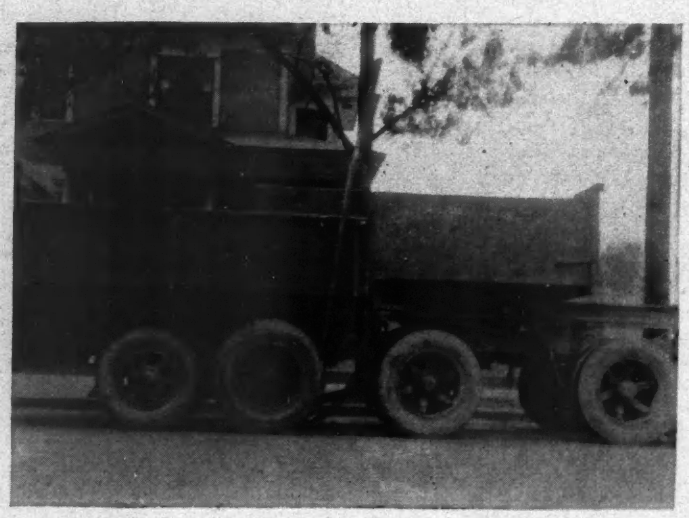
Newton had the valuable faculty of being able to communicate to others the most profound of his speculations. He showed great generosity and charity to all, was of medium size and inclined to be corpulent, and many tales are told of his extreme absence of mind. He had none of the other usual eccentricities of genius, and was modest, candid and affable to all. Newton said late in life that he felt himself to be "only a school boy picking up smoother pebbles and prettier shells on the sea-shore while the great ocean of truth lay all undiscovered before him."

Engineering Notes

Vierendeel Trusses are of unique and pleasing design and are coming into use in several parts of the world, especially in Europe. The main feature of the truss style is that it is composed of rigid rectangular and trapezoidal frames with no diagonal bracing at all. The first bridge was built in 1898 but up to the present time forty-two bridges with a span of 82 to 236 feet have been constructed.

The elimination of diagonal bracing is accomplished by providing absolutely rigid end connections. This type of construction makes for economy as less material is necessary for a given span and therefore the bridge is considerably lighter. Its rigidity withstands impact and vibration, and view through the bridge is unobstructed. In addition, the bridge is very artistic in appearance.

These bridges have proved satisfactory for rail, foot, and road traffic. The main difficulty in design is that the truss is statically indeterminate. Prof. Vierendeel has, however, worked out a very satisfactory method of calculating stresses. The Professor has also worked out designs for spandrel-braced arches and suspension bridges with the same type of truss. The suspension bridge design employs rigid connectors from cable to bottom girder. No bridge of this type has been actually constructed, however.



Courtesy Rock Products

Empty truck backs up against trailer, pushing chassis from under loaded body and so transferring it to the truck.

A Self-Propelling Mooring Tower for dirigibles has been tested at Akron and put into service. Its object is to reduce the size of the ground crews and at the same time to provide for outdoor mooring.

The tower consists of a triangular pyramid frame mounted on three crawlers. The tower is 76 feet high and the crawlers are on a 125 foot circle. Two of the crawlers are motor driven by variable voltage direct current motors while the third crawler is used for steering purposes. The electricity is provided by a self-contained gasoline power plant. The structure is capable of speeds up to 2 m.p.h. and is readily maneuverable in all directions. The whole tower is controlled from a control cabin on the top of the powerhouse which is in turn located in the lower part of the pyramid.

The whole structure weighs 125 tons and is capable of hauling in the largest airship against any wind and of transporting it into the hangar. The winding in mechanism is driven by electricity and the line from the ship comes in through an anti-friction bearing spindle set in the top of the pyramid structure.

Ingenious Trailer design now enables firms to make long distance truck and trailer hauls of heavy and cheap materials such as sand, gravel, etc. Also, the time required for delivery is a great deal less than delivery by rail.

The modern trailer design is steadily increasing the economical hauling distance. One of the latest type trailers is loaded, attached to the loaded truck, and the unit driven to the construction. Here the two parts are separated, the trailer being parked by the roadside while the truck backs up and discharges its load. The truck then returns and backs up against the front of the trailer in such a manner that the trailer body is transferred from trailer chassis to truck. The truck then again backs up to the construction and discharges the load of material in the trailer body.

The type of truck employed usually is equipped with six wheels which are supplied with heavy pneumatic tires. The trailers are four-wheeled and employ double pneumatic tires.

Frozen Concrete in Russian Construction. While in the United States it is common practice on winter construction to heat concrete aggregate and mixing water and then to protect the placed concrete against freezing, the exact opposite practice has been followed on some work done in Ukraine where concrete is allowed to freeze as soon as placed and is then protected against thawing until the approach of spring brings warm weather when the concrete is brought from cold storage, allowed to thaw and set in the usual manner.

Just before setting takes place cement particles are surrounded with a thin envelope of water, and if the concrete is then rapidly frozen it consists of a mixture of sand, cement, and ice particles. If the forms are left on concrete work until the concrete thaws out, the cement particles then combine with the water present and harden and set in the usual manner. The methods used on the work described are such that this takes place.

The cement used is cold, the aggregates are cold and dry and the water is at a temperature between 40 and 50 degrees F. The concrete is mixed in a sheltered place and placed in thin layers. It is rapidly and thoroughly tamped to give a good bond to the previous layer and is allowed to freeze as soon as possible. Success in the work requires that each layer be securely bonded to the previous one and that the whole mass of concrete be frozen solidly. After placing the concrete, the forms are covered with boards and slabs are covered with straw or sand which is wet down and allowed to freeze to prevent thawing of the concrete immediately beneath.

Because of evaporation of water from the frozen

concrete during the winter, to secure proper setting and hardening, it is necessary to wet the concrete as it thaws. This operation is one that calls for considerable skill, as enough water to permit proper hardening must be provided without washing away the cement particles. For massive work special water pockets are provided from which water percolates through the mass.

Built-up Wood Columns have been tested by a large laboratory and found to have many advantages over the solid wood column. In the first place the same size of material may be used for various sizes of columns. Secondly, short lengths and odds and ends of good lumber can be used up. Also, the column may be handled in small pieces before the final laminating and so makes handling easier. Another advantage is that laminating presents the possibility of lessening, if not avoiding, excessive warping of the column. Again, expensive woods may be used in the highly stressed parts of the column while cheaper woods may be used in the less important parts. The main disadvantage to the type is that a slightly larger size column is required than if it were of one solid stick of wood.

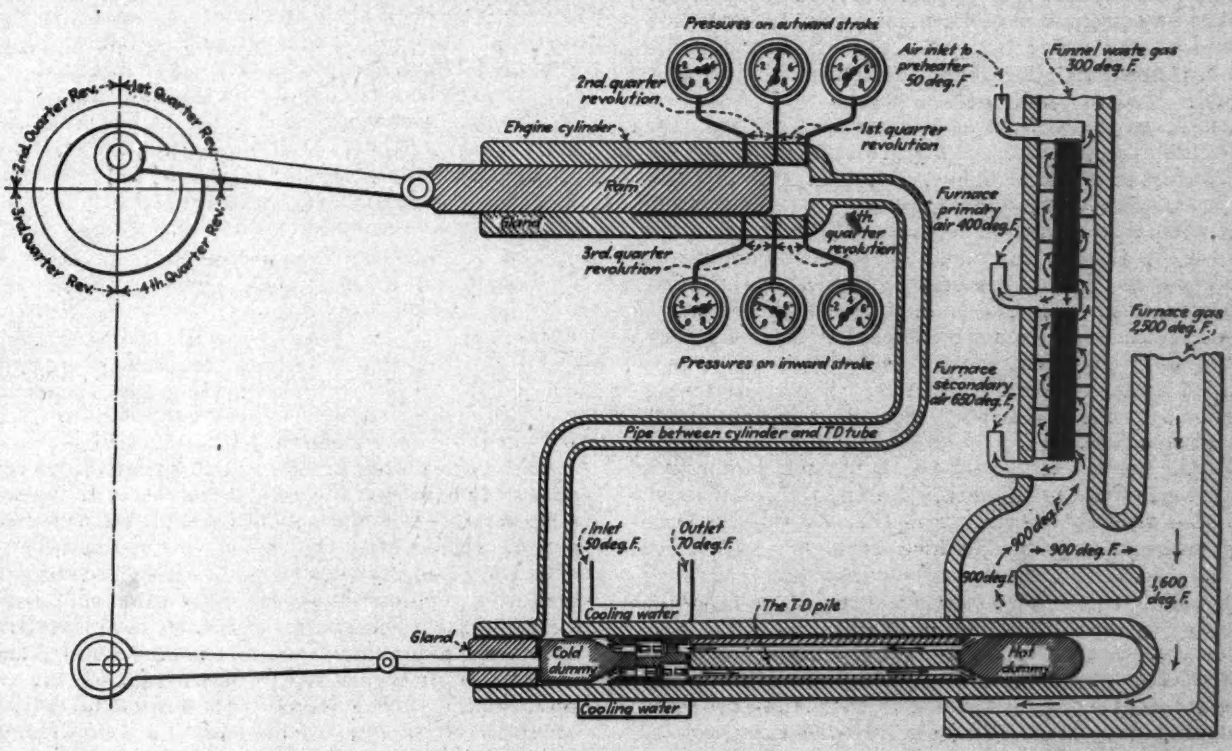
The strength of the built-up columns varies, but is from 75% to 90% of the same size column of solid wood. If the column were assembled with glue it would have almost the strength of a solid stick. However, it is easier to assemble the laminations by means of nails, bolts, dowels, etc. By proper use of fastenings and method of loading the columns they should prove very satisfactory in actual use.

The Return of the Steam Driven Auto and the development of the steam driven airplane is being predicted due to the invention of a new type of boiler. The difficulty faced by the old type of boiler was the fact that it usually employed a single long coil of tubing. Due to this tube heating to redness in spots, it necessitated frequent and expensive replacements. The new boiler uses a number of shorter coils, each of which opens at top and bottom into a surrounding water cage of larger tubing which serves as the main water reservoir. The boiling of the water keeps it in active circulation, entering the water cage at the top and returning to the coils at the bottom. The steam is driven off from the heated water at the top of the water cage and passes into a series of larger tubes which serve as steam collectors, and also bring it in contact with the fire, superheating it and making it thoroughly dry. Before reaching the engine, the steam is subjected twice to this reheating process.

Water Expansion Engines are claimed to have a great future as the prime movers of ships and locomotives. Although the idea of operating a reciprocating engine commercially by the expansion and contraction of water seems rather fantastic to most American engineers, the Royal Society of Arts in London recently gave over an entire meeting to a serious discussion of the engine.

The heart of this engine is the reciprocating "TD" (thermodynamic) pile which slides back and forth within the "TD" tube. This reciprocation alternately heats and cools the water in the lower cylinder thereby producing the forces which operate the engine. The "TD" pile is constantly heated by a built-in furnace on one side and cooled by water on the other. The result of moving this pile one way is to displace all the water, making it cold. Conversely, the effect of moving the pile back is to displace all the water the other way making it hot. With these movements, the total volume of water in the system is increased or decreased.

While the larger sized engines of this type have not a greatly increased efficiency over steam engines, the smaller sized engines have been found to be considerably more efficient.



Courtesy Power

Diagramatic sketch of the water-expansion engine, showing reciprocation of "TD pile" due to alternate heating and cooling of water in lower cylinder. *See page 176 for illustration of cycle.*

Recent Books

THE METALLIC STATE. By W. Hume-Rothery. The Oxford University Press. 372 pages. Illustrated. Price $9.00.

This book is a much-needed treatise on the electrical properties of metals and alloys. Its main purpose is to collaborate the two sciences — Physics and Metallurgy — for even at present there seems to be little connection between the two. The "Practical Metallurgist" gathers together an enormous amount of data in connection with the various metals of commercial importance, but he has never really tried to investigate systematically the properties of metals and alloys from the point of view of the Periodic Table, in order to derive the general underlying principles involved.

Then the Physicist, while investigating the many physical properties of metals, has not only often forgotten the Periodic Table, but he has been so separated from scientific metallurgy that a great deal of experimental research of the highest quality has been performed on specimens which any scientific metallurgist would condemn as unsuitable. Further, the Metallurgist still tends to discourage research work on metals which seem to be of no possible commercial value. This makes the development of Physical Metallurgy as a science difficult, for in most cases the rare or commercially unimportant metals are the ones which occupy "key" positions and which provide clues for general principles.

In view of what has been said this book was written to give a general survey of existing physical theories and of the data on which they were based. Since that at present the theoretical work has resulted in little real quantitative theory or systematization, the book has been divided into two sections, one dealing with the facts and the other with the theories.

The first section is a general account of electrical and thermal properties, concentrating on subjects not found in the average textbook. The effects of temperature, pressure, stress, deformation, annealing, and magnetic field on resistances of metals and alloys are treated in detail. Several chapters are also given over to thermal conductivity, for high thermal conductivity is of utmost importance in everyday uses of metals and alloys, and many developments in high-speed machinery and internal combustion engines are only possible because the thermal conductivity is great enough for heat generated in the machine to be withdrawn sufficiently rapidly. The effects of temperature, pressure, and deformation are again outlined. A general survey of emission phenomenae is also included to serve as a basis of later electronic theories. Three classes of emission are outlined, namely, photoelectric, thermionic and intense field.

In the second section of the book, the simple free electron-gas theory of Drude is the first to be discussed. The plan used by the author in this section is to give each main theory a chapter. Each begins with a general description in non-mathematical form, followed by a detailed description including derivations of the various equations, and then concluding with a critical discussion. After the theory of Drude other old complex electron-gas theories are discussed, followed by intermediate theories of Thomson, Wien and Gruneisen, Bridgman, and Hall. The electron lattice theory of Lindeman is discussed at length. Finally the Sommerfield theory and the New Statistical method are outlined fully, together with later modifications.

In conclusion, the book outlines in a chapter the Periodic Classification and its relation to the crystal structure of metals. In the Appendix appears a summarized translation from the German of Dr. F. Bloch's paper on Conductivity. The whole book knits together enough data and discussion for a clear fundamental understanding of a new science — Physical Metallurgy.

E. H. A.

ARCHITECTURAL SHADES AND SHADOWS. By Edgar Greer Shelton. D. Van Nostrand Co., New York. 159 + viii pages, index, illustrated. Price $3.50.

In this volume, Mr. Shelton has gone into the problem of casting the conventional shades and shadows used in architecture in considerably greater detail than is usual when treating this subject.

Although not strictly a part of the work of casting shades and shadows, india ink rendering is briefly discussed in the opening chapter. The author thereby assumes, correctly, that the casting of shades and shadows is merely a preliminary step to rendering, so includes this brief résume of rendering preparation and procedure.

The following four chapters take up in logical order, first, the fundamental assumptions and considerations underlying formal shades and shadows, and then what he considers to be the three distinct methods of casting them — the method of oblique projection, the method of auxiliary or tangent cones, and the method of auxiliary or slicing planes. Another chapter takes up the orders of architecture, indicating how each is to be handled when casting.

A very liberal use of illustrations, both of rendered drawings and of carefully worked out diagrams serves to make the book clear and understandable, so that a novice at the work should be able to follow it easily. The final chapter contains over two hundred representative problems which follow the text closely.

The book assumes that the student has a knowledge of descriptive geometry but the author has endeavored to keep his explanations as simple as possible. It should prove an excellent work for the beginner and a handy reference volume for the more advanced.

A. G. D.

ELECTRIC SYSTEM HANDBOOK. C. H. Sanderson, Editor-in-Chief. McGraw-Hill Book Co., New York. 1131 pages, 5 x 8. Illustrated (Index). Price $5.00.

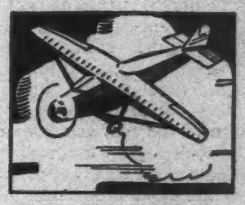
Eight specialists in the electric light and power field present in this book their combined work, giving a complete survey of the component parts of the entire electric system, telling of their relation, one to the other, and discussing the features of their design, construction, operation and maintenance. The first section begins with a discussion of the fundamentals of electricity. Its nature and characteristics are explained by the use of the electron theory and the electrical units are named and defined. Then follows a discussion of the fundamentals of design, construction and operation of generating and transforming equipment and their application. The auxiliary electrical equipment, switchgear,

(*Continued on page 177*)

Every year is 1492 in telephone making

Raw material from the far corners of the world.

It's always the era of exploration in telephone work. New manufacturing processes are being developed, new sources of raw materials found, new methods originated for distributing telephone supplies . . . New kinds of apparatus are being built to meet the needs of a rapidly changing world. Take communication products for example. Western Electric makes equipment for aviation, for police radio, for ship-to-shore telephony . . . Intensely interesting, this work is. There is in it the spirit of the adventurer, of the pioneer. The same spirit runs through all of Western Electric's many-sided activities—serving the Bell System in the triple capacity of manufacturer, purchaser and distributor.



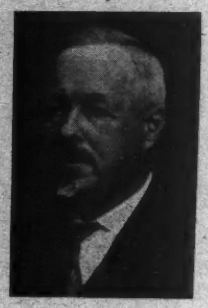
The modern pilot telephones the ground.

No anchoring to tradition, here.

Western Electric

Manufacturers . . . Purchasers . . . Distributors

SINCE 1882 FOR THE BELL SYSTEM



PROFESSOR GEORGE L. HOSMER

Professor of Geodesy
Department of
Civil Engineering

In 1911 the Institute selected for a Summer Surveying Camp a strip of uncharted territory overlooking the northeastern shore of Lake Gardner. Each year since then, Professor Hosmer, who is in charge of camp instruction, has worked with the students in camp and has given them full benefit of his experiences both as an engineer and as an expert woodsman. Being by natural temperament a lover of the outdoors, he specialized in Geodetic Surveying as a means of satisfying this inclination.

Professor Hosmer was born December 31, 1874 in Lynn, Mass. His earlier education was afforded him through the public schools of Lynn and Woburn and the High School of Woburn. In 1893 he registered in the Institute as a student in Mechanical Engineering but at the end of his first year transferred to Civil Engineering, having become interested in the Geodetic Option. During the next three years he majored in mathematics and astronomy, choosing a complete course of study which, however, did not lead to a degree.

He entered upon his career as an educator the Summer immediately following the completion of his course, at which time he became an instructor in the then, Summer School of Topography, the forerunner of the present Summer Camp. For the next two years he worked as assistant to Professor Burton in the Civil Engineering Department, after which he became an instructor. In 1907 he was appointed an Assistant Professor and a few years later was made Professor.

Teaching first appealed to Professor Hosmer while he was yet a boy in High School. His idea of teaching, however, was that what he taught should be backed up by actual experience. Much of this experience he gained during the Summers from 1895 to 1911 working on numerous engineering projects which included work in sanitation, water supply, boundary surveys, water power development, grade crossing elimination and other types of work. In 1900 he made observations of the total eclipse of the Sun as a member of the M. I. T. Eclipse Expedition to Georgia. Again in 1901 he went with an expedition to Sumatra which observed for magnetic elements during the eclipse and made miscellaneous astronomical observations. During this time he made Gravity observations with the pendulum both at Sumatra and at Singapore. The Carnegie Institution was at that time interested in the effect of the Sun's eclipse upon the magnetic declination of the earth and in 1905 appointed Professor Hosmer to make observations in Labrador. As a result of this experience Professor Hosmer has been able to present his subjects of instruction most interestingly.

He has done much in the way of writing and research work. Among his works are included text books on Geodesy, Practical Astronomy, Navigation and two volumes on Surveying in the writing of which he collaborated with Professor C. B. Breed. Another of his studies of a more personal nature, is his book "Hosmer Genealogy" in which he has traced the Hosmer family through records in the United States and England back to about the year 1500.

Professor Hosmer is a member of the American Society of Civil Engineers, the Boston Society of Civil Engineers, the American Society of Military Engineers, the Society for Promotion of Engineering Education, the N. E. Historical Genealogical Society, the Society of Colonial War in Massachusetts, the Sons of the American Revolution, and the Massachusetts Rifle Association. He is also a Fellow of the American Academy of Science and the American Association for the Advancement of Science.

During his career, Professor Hosmer has found recreation, apart from his work, in extensive reading, in rifle and pistol shooting, violin playing, photography, camping and genealogical researches. He derives his greatest pleasure, however, from exploring the woods, rivers and lakes of northern Maine. The passing of the years has in no way lessened his ardor for accompanying young camping enthusiasts on their trips into the woods. Professor Hosmer is a master of his profession and by his sympathetic interest in their endeavors he instills in his students the desire to be such engineers as himself.

Taking Stock in 1931

(*Continued from page 153*)

ation of raw material, have not seriously had to face competition. Others have developed historically with a minimum of departure from tradition. In all of these there are tremendous opportunities for development of new methods, new products and more efficient organization. Innumerable examples of intense and even dramatic interest might be given of the success of engineering and research in the metal, oil and other industries within the past two, or five, or ten year period. A physicist friend of mine who has been strikingly successful in organizing the research work of an oil company during the past couple of years said to me the other day: "For a trained scientist to save or earn a hundred times his salary for some of these companies is like picking apples off a tree!" While not many would be as successful as this man, nevertheless it is certain that there is a large element of truth in this statement.

The "backward-in-research-and-engineering" industries are not yet educated to the advantage to be derived from highly trained technical help, and now employ little or none of it. Engineering graduates do not want to go into these industries, where they are not understood or properly employed, and in good times they all take the preferable positions in the advanced technical industries. But in these hard times, with jobs scarce, many of our graduates are forced to take the less preferable positions in the more backward industries. *If these young engineers really have the power to assist these backward industries which we believe their training to have given them, they will re-create these industries and, by making good in them, develop in them a permanent future demand for engineers.*

The president of a southern textile firm recently asked the advice of a prominent consulting chemist as to how to go about getting the benefits of this research about which he had heard so much. He was advised to ask the head chemist in a certain university to recommend to him a chemistry Ph.D. who had made a fine university record followed by three to five years successful practical experience, — irrespective of whether he knew anything about textiles or not, — and to put him in his plant for a year with no specified duties, and await results. At the end of the year the president reported that his whole plant was in process of reorganization as the result of this young chemist's suggestions and discoveries, and that his firm was completely "sold" on the value of employing technically trained men.

In such ways it is that the present hard times may have the indirect influence of increasing the appreciation of and the demand for scientists and engineers.

The Engineer in the Future

Last spring I had occasion to outline an argument to justify scientific education and research against a charge that these were being overemphasized. Let me quote two paragraphs of that argument:

"The greatest agency for alleviation of human suffering and for affording opportunity for cultural pursuits is *increased productive power*. Compared with it, problems of distribution are secondary, for without it there is little to distribute. It is the only thing (except the hypothetical application of birth control) which has prevented, or can in the future prevent, the limitation of population by suffering, want

and untimely death to a degree in comparison with which problems of temporary maladjustment or unemployment are insignificant."

"The greatest economic, social and moral problem of the world is that of securing universal good will and cooperation. Toward achieving these, factors such as quick and widespread communication and transportation between all parts of the world, the personal contacts that come with reading, travel, radio, movies, etc., the world interest in an Einstein or a Lindberg, these are factors whose power far exceeds treaties, economic agreements or forms of governmental organization or control. These factors, together with opportunity for widespread education, are all the results of science and of the facilities, wealth and leisure which science has made possible."

These statements, which can be greatly elaborated, attribute to the scientist-engineer a fundamental role in shaping civilization. It is difficult to imagine a future in which the engineer will not be even more important than he is today.

Similar views are strikingly stated by Professor James T. Shotwell, prominent historian of Columbia University, in an article in Scribner's for July. He leaves open the question as to whether the changes in our civilization are altogether desirable, but he says:

"— But, whatever theory one may adopt as to the ultimate outcome, *the pathway to the future is in the hands of the engineer*, not of the economist, and no one, least of all the engineer himself, knows what surprises he may have in store."

Public Utilities

(Continued from page 159)

interruptions to service.

Engineers of the second group investigate and analyze the troubles which may develop in spite of the most careful supervision, make the repairs as necessary to restore service as soon as possible, and submit recommendations for immediate or future consideration.

Commercial Engineering

This division includes the engineers whose duties bring them into contact with the public to be served. They study the customer's needs, assist him in arriving at a solution of his special problems, and after consultations with the design and operating engineers submit recommendations for adequate service.

Research

The research engineers are occupied with investigations which ultimately bring benefit to the company and to the public. For this purpose many of the larger utilities maintain laboratories of the highest type and carry on work of extreme importance to the industries. The laboratories of many of the companies combine with their routine testing and standardization special investigations suggested from operating experience. These laboratories employ a large number of engineers of different types and offer excellent opportunities to the young engineer.

It is impossible, in an article of this character, to go far into the details of the work of each engineer. It may be said that the Public Utility Companies require the services of practically all kinds of engineers, Civil, Mechanical, Electrical, Hydraulic, Chemical, etc., as well as specialists in the various departments of engineering.

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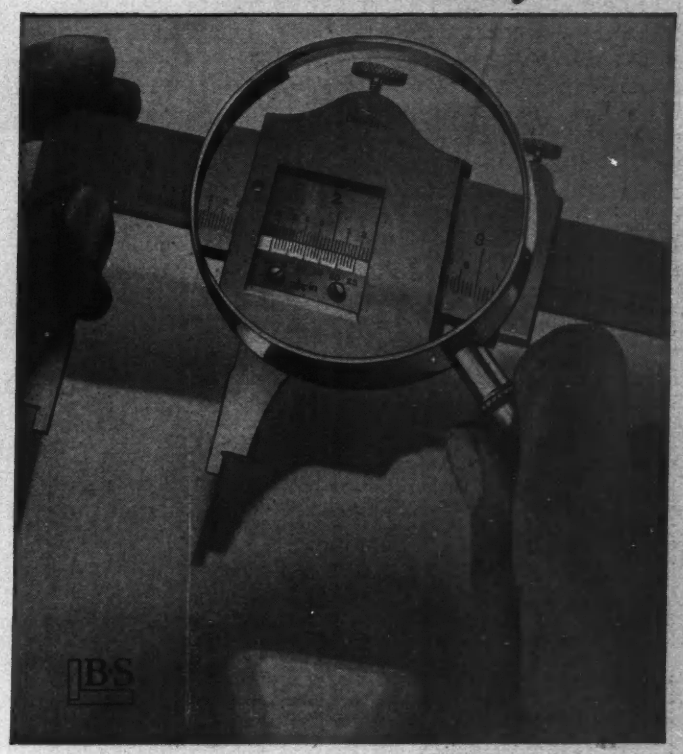

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Chemical Identification of Solids by Crystallography

(*Continued from page 155*)

scopes" and "polarizing microscopes" are on the market. These instruments are simply toys and are no more capable of convenient use in routine identifications than a one-horse shay fitted with a buckboard motor is capable of making a comfortable transcontinental tour. It is doubtless due partly to the sale of these half-breed biological microscopes to the unsuspecting chemists that optical identification is so little used by them. The true petrographic microscope is not a biological microscope with accessories, but is an especially designed tool intended for its own field. Its magnifying ability is more or less of an incidental feature, for it is primarily made for optical trickery, not for perfection of magnified image.

Not only does the petrographic microscope allow of the determination of the fundamental constant, refractive index, but several secondary constants, completely dependent upon the interrelations between the three refractive indices, are also determinable. These include: *optic sign*, *optic angle* and *birefringence*. Dispersion of each of the three refractive indices is also measurable, as are also the secondary constants dependent on both refractive index and dispersion, namely: *dispersion of the optic angle* and *dispersion of the optic plane*. Finally, by taking into account the space relations between optical properties and geometrical properties of a crystalline substance, a set of highly important facts is ascertainable which are included under the name *optical orientation*. Color is of no diagnostic consequence except in the most elementary instances, but in the case of colored substances (and this is intended to include the ordinary dark-appearing substances), a variation of color with the direction of vibration of the light by which the color is observed, is an important optical property of diagnostic value, known as *pleochroism*. All of these additional properties tend to raise confidence in the sureness of the identification made on the basis of refractive indices alone.

Some of the great advantages of an optical identification accrue from the fact that there is no lapse in logic in the deduction. There is therefore no necessity for any unwarranted assumptions to fill the gaps. Suppose that a mixture, in the form of a grey powder, is received for analysis. A preliminary microscopic examination reveals that the grey powder is made up of a mixture of only two kinds of particles: dark ones with high refractive indices, and light ones with low refractive indices. This observation is as straightforward and elementary as that a box full of black and white marbles is a box full of black and white marbles. From there on the analysis proceeds on, let us say, the light colored particles without regard to the presence of the dark colored particles, and when an identification is reached, the analysis is run on the dark colored particles just as if there were no light colored particles. In the end an unequivocal answer is ready: the mixture consists of compounds AB and CD. There is no necessity for assumptions regarding the likelihood of A combining chemically with D rather than B, and of C combining with B rather than D, to give a resulting mixture of AB and CB. The chemical arguments for one rather than the other combination are usually based on relative stabilities in the presence of a solvent. Needless to say, the mixture may never have seen a solvent, and it may not even be stable. In simple cases like the one cited, a quantitative analysis will sometimes give a purely chemical clue as to the particular combination, but the chemist's hope here is really confined to truly simple cases. For example, here is the case of an analysis from the writer's practice:

CaO	.239	atomic %
MgO	.250	" "
SiO_2	.177	" "
P_2O_5	.127	" "
Al_2O_3	.105	" "

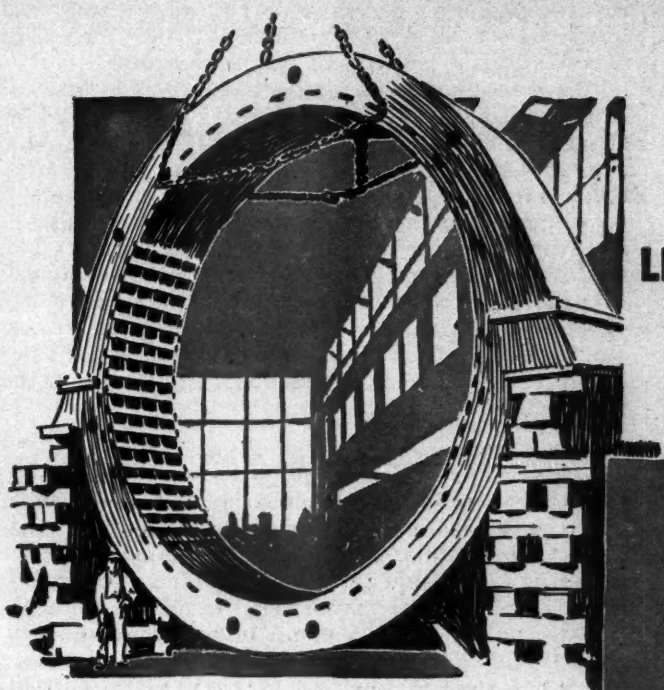
It can be shown that for this analysis, assuming that the values are correct to about the second significant figure, that there are at least thirty odd combinations of total acidic material with total basic material, to say nothing of how many further combinations are possible by separating these combinations into compounds. The estimate given was limited by the assumption that the possible compounds were relatively simple, a wholly unjustified assumption.

Optical methods, then, have the advantage that the compound is actually seen as it is identified, so that its real existence is assured. Another advantage is that polymorphous forms of the same substance or isomers are as easily distinguishable from one another as any two different substances. This is simply because these substances differ in their physical makeup, a feature which displays itself in the refractive indices which are functions of the physical makeup. In the same manner, the various hydrates of a compound are easily and automatically distinguished. For example, the optical properties of calcium sulfate in several states of hydration are given in the accompanying table.

		refractive indices			*optic angle*	*dispersion of optic axes*	*optical orientation*
	Optical character sign		β	γ			
$CaSO_4$	biaxial (+)	1.571	1.576	1.614	42°	$\rho<v$	X = c Y = b Z = a
$CaSO_4.\frac{1}{2}H_2O$	uniaxial (+)	1.55	——	1.57	0°	——	——
$CaSO_4.2H_2O$	biaxial (+)	1.520	1.523	1.530	58°	$\rho>v$	X>c = 37½° Y = b

Provided he knew that the compound was calcium sulfate, the crystallographer would not even need to make any measurements in order to determine which hydrate was under observation, for the qualitative differences between the various possibilities are so strong that only a glance is necessary for a determination.

One of the purely scientific uses of optical identification is in the examination of the phases in the investigation of stability fields of compounds under various conditions, *i.e.*, in the construction of the temperature-composition diagrams of physical chemistry. Prior to the introduction of optical methods, serious mistakes in detection and identification of phases were made in this type of work. The reason for the mistakes is easy to understand. In making a temperature-composition diagram, the usual method is to make a mixture of a given composition and heat it to melting. As it cools, the melted material crystallizes in one way or another and the object is to determine the nature of the phases present at every temperature. At all times the sample has the same



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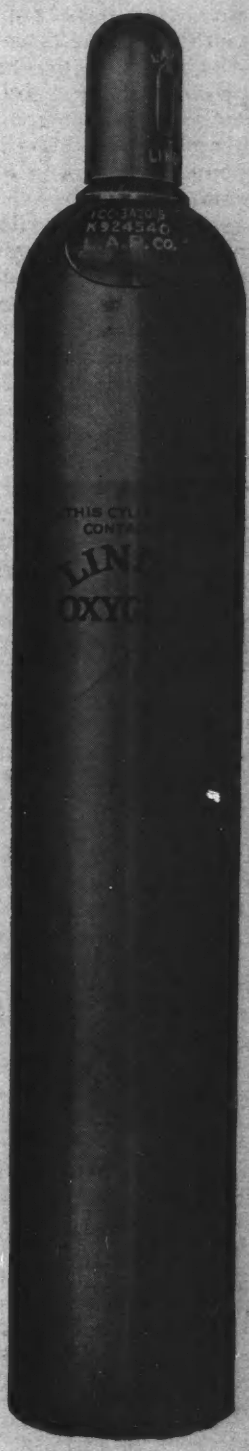

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composition it had to begin with, so the chemist is helpless to say what compounds exist in the melt at any given time. To make assumptions about the composition is just what the experimentation is designed to avoid. In the past, this question was investigated wholly by the heat effects, for as a new phase makes its appearance in the melt as the temperature falls, a certain amount of heat is liberated or absorbed. Unfortunately, there are certain assumptions one must make even in regard to the interpretation of heat effects, especially in complicated cases. With the advent of the petrographic microscope to this branch of physical chemistry, many cases of temperature-composition systems had to be re-worked. There is a vast difference between guessing that a compound ought to be present because of a certain effect and actually seeing the compound. Unfortunately, investigators in other branches of physical chemistry have not made so much use of optical methods as the phase rule experimenters.

Of late, the ceramist has become an industrial physical chemist and has found that the petrographic microscope is an indispensable tool for controlling the properties of his products. Of course, a piece of porcelain ware or a refractory brick is of just the same composition after firing as before, but its properties depend on the extent to which a certain desirable phase has formed and on the texture of the formation. Chemistry is helpless to give an answer to problems of this sort, as was realized by progressive ceramists some time ago. It is interesting to note that the Massachusetts Institute of Technology has been giving instruction in the control of ceramic products through the aid of optical crystallography for many years.

Among the more spectacular advantages of optical identification, but advantages which are only useful in certain instances, it might be mentioned that if necessary, all measurements may be made on an unknown crystal fragment, and still have the fragment intact and unconsumed when the dentification is complete. This feature has its advantages if the material is scarce or extremely valuable, or if it would lose its identity as the substance in question, by chemical attack. It is also possible to work with extremely small amounts of substance, and this is often of very real importance. An optimum quantity for a single index comparison is several grains of the material which pass a sieve of 100 meshes to the inch, *i.e.*, particles of just below $\frac{1}{200}$ th inch in diameter.

An almost cultural appreciation of certain chemical matters always becomes the possession of the student engaged in the study of optical crystallography. He soon earns to regard the label "chemically pure" with suspicion, for a single glance through a petrographic microscope at many reagents so labelled, reveals the impurity content with rather startling clearness. The student also learns to regard the word "amorphous" with extreme suspicion, for he quickly finds that many of the substances, such as waxes, certain gums, resins, etc. that his general chemistry texts had pointed out to him as examples of amorphous substances, have the unmistakable earmarks of crystallinity.

Geometrica Methods of Identification

Every crystalline substance is built up of units which may consist of groups of atoms, ions or molecules. These units, which are known as *unit cells*, are added one to another during the process of crystallization, in the same manner that blocks of stone are laid one on top of another to form a stone building. Every external property of the final crystal partakes of the nature of these elementary units. In particular, the external surfaces that the crystal takes on, are surfaces which run through rows of units, in the same way that the surface of a tiled floor is determined by rows of tiles extending in two dimensions. It follows that by a study of the surface of a crystal, it is possible to deduce something of the shape of the unit itself.

It is evident that the unit cell of a crystal must be character stic of the substance which it represents, for it is made up of that substance. It is this feature which enables the crystallographer to identify a crystalline substance by a study of the surface of a well-crystallized sample. From this study he deduces what amounts to the shape of the unit cell and is then in a position to look for corresponding values in tables.

In the general case, the unit cell is a perfectly general parallelopiped, with three unequal sides and three unequal angles between the sides. These six constants are known as the *elements* of the crystal and are uniquely characteristic of the substance. The geometry of the space we live in allows this general unit cell to degenerate into five specialized types of unit cells. Each of these six possible kinds of unit cells constitutes a general category of crystals, known as a crystal system. The most general five crystal systems can be identified by simple angular measurements on an instrument known as a goniometer (Figure 2). The most simple case of a unit cell, the cubic cell, represents the isometric crystal system and this type of crystal cannot be identified by angular means.

The surface of a well-grown crystal is facetted like a cut diamond, except that the facets are of natural origin and their placement follows very definite laws. This surface is studied by measuring and recording the slope or slant of these faces. In practice, this is done by bringing each face to a position on the goniometer such that it reflects the image of an illuminated signal to a fixed point. The slope of the crystal required to produce this condition is then read in a manner corresponding to taking a reading of the latitude and longitude of a point on a sphere. By a study of all the readings thus taken (usually accomplished graphically), the shape of the unit cell is arrived at, and the crystal identified.

(*Continued on page 174*)

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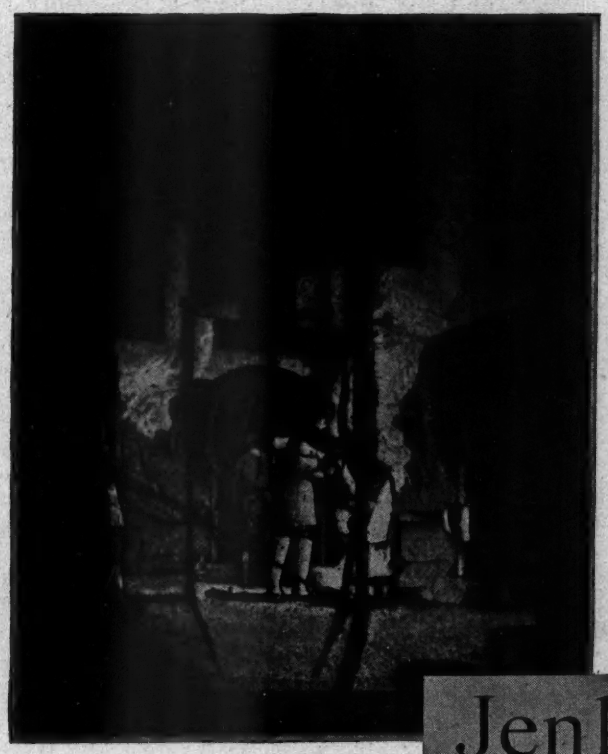

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Crystallography

(*Continued from page 172*)

This type of identification of solid substances was considerably developed by the great Russian crystallographer, Federov, and more recently by his student, the late T. V. Barker of Oxford. To give an example of the usefulness of this method, it is interesting to mention a test made by Barker. Barker had his assistant prepare him nine unknown crystals of all sorts of substances. All of these were identified in the time noted after each in the following list. It should be mentioned that number 4, which took 4½ hours, was actually a rather easy one and the excessive time was due to a printer's error of 2° in the original data. The remarkable thing is that it could be identified in spite of this error.

No. 1. Ammonium magnesium chromate (monoclinic, 3 hours).

No. 2. Rubidium tetroxalate (anorthic, 2 hours).

No. 3. Propyl α-picolinium mercuri-iodide (monoclinic, 1 hour 15 minutes).

No. 4. Phthalylphenyl hydrazide (monoclinic, 4½ hours).

No. 5. Tetramethylammonium mercuri-iodide (orthorhombic, 1 hour).

No. 6. Methyltriethylammonium mercuri-iodide (anorthic, 1 hour).

No. 7. Thallium tetroxalate (anorthic, 3½ hours).

No. 8. Triethylpropylammonium mercuri-iodide (monoclinic, 55 minutes).

No. 9. Tetraethylammonium mercuri-iodide (tetragonal, 30 minutes).

The Use of Rubber for Bearings is now possible through a new process of boning rubber to metals. On many things, such as shafts running in water on ships, hydraulic power turbines, and sand and gravel pumps, it is not practicable to use oil for lubrication, this will be a boon as water or other fluids not injurious to rubber may be used. Babbitt and bronze along with other soft metals have been used so long that it is hard to imagine anything else being able to take their place. However, when it is considered that rubber properly compounded and vulcanized will stand abrasion much better than steel, babbitt, or bronze, it becomes easier to consider the future of this new process. Rubber, like water is almost non-compressible and is capable of supporting a shaft of great weight with negligible deflection. Another property of rubber is its remarkably low coefficient of friction when wet. In tests it has been decided that under certain conditions such as those mentioned above, the rubber bearing is better fitted than any other bearing now available for use.

Bottle Manufacture

(*Continued from page 158*)

dually increasing it until the blocks throughout the tank are thoroughly dry and well heated after which the producer gas is introduced. The heat can then be more rapidly increased without serious results to a point sufficient to melt the glass batch—2600 degrees Fahrenheit.

The basic material used in making glass is pure silica, which by itself is very hard to melt, making it necessary to mix with it some fluxing or softening material or materials. Lime is also used, partly for fluxing, but more for the purpose of clarifying and hardening the glass during the melting process. When these simple materials are used, they produce a light clear colored glass, and when flint or colorless glass is desired, other materials are added. Different colors are produced by mixing or combining various chemicals of a metallic nature.

A glass batch is the combination of the necessary materials in proper proportions usually based upon 1000 pounds of sand or some multiple thereof thoroughly mixed and ready for the furnace. As the glass is taken from the furnace by the workmen, the batch is introduced into the melting end, thus keeping the tank filled to the glass line.

Working Force in Shops

The working force around the furnace is divided into shops each consisting of three blowers and from three to five helpers, according to the kind of ware being made. The helpers are usually designated as "boys" but in reality most of them are young men ranging in age from 18 to 24 years. Two of the blowers in each shop do the blowing of the bottle while the third finishes the neck at the "glory-hole," but they change the work with each other as often as agreed among themselves. Each Ring-hole around the tank is intended as a "shop" and each shop performs its work entirely independent of the others. When all the shops are filled and all are at work, the general appearance of the place suggests a busy bee hive with much confusion and disorder, but instead each man, whether blower or helper, has his particular work to perform which is done without the least interference with others.

Before beginning work in the morning or afternoon, it is necessary to have the moulds, the blow pipes, and clamps all properly heated. One of the blowers in each shop then begins work by inserting the blow pipe through the ring-hole and by touching the surface of the melted glass, revolves the pipe in his hand until the required amount adheres thereto; when it is equally distributed around the center of the pipe with a slight puff of the breath expands it from the center. The glass is placed in the mould where it

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is blown sufficiently to take the form prescribed. After the first blower gathers his glass and is rolling it upon the plate block or stone, the second blower makes his gather, then proceeds with the work the same as the first blower, and thus the work is continued. When the first bottle is blown in the mould, the mould boy opens the next mould then takes the bottle from the first mould, places it upon a plate, from which the "snapping-up" boy takes it with a pair of pincers made to fit the neck of the bottle. He places it in the snap and inserts the neck into a small round opening in the "glory-hole" where it is reheated and then finished by the finisher with a hand tool. The bottle is then carried on a paddle by the helper, designated as "carrying-in boy," to the annealing oven where it is placed under a hot fire from which it is pulled only as other bottles are made and placed therein. Thus, the bottles are cooled gradually and upon reaching the other end of the lehr, are placed in wareboards. Inspection by packers or assorters completes the process of making bottles by hand.

Hudson River Bridge

(Continued from page 157)

onto Ft. Washington Avenue, one block west of Broadway, near the center of Manhattan Island. From Ft. Washington Avenue, two sub-surface tunnels carry traffic to the other side of the Island. At the plaza, marginal roadways on the north and south sides of the bridge make connections to streets running north and south, while on-bound and off-bound roadways between the marginal roadways and the main approach make direct connection with Riverside Drive. So cleverly have these ramps and turns been arranged that no one traffic lane, in either direction, north or south, crosses any other.

Cost Analysis

The preliminary estimates stated that the cost of the entire structure would amount to sixty million dollars. The actual construction cost will be in the neighborhood of $38,560,000. Of this amount over $27,000,000 had been contracted for by February 1, 1931, when the work was 70% complete. An analysis of the contracts shows that the steel for the cables and the anchorages was the most costly, involving nearly a third of the entire expense. The towers and the floor steel cost $11,000,000. Construction of approaches, anchorages, foundations, demolition, excavation, and miscellaneous contracting make up the remainder. This enormous cost is being financed without taxation of the people of either state by issuing bonds in the name of the Port Authority. Aid rendered by the state is temporary, to be repaid with interest when the bridge is in operation.

Revenue will be derived from all classes of traffic other than pedestrians, the charge for pleasure vehicles being fifty cents. When the revenue thus collected has met the entire cost of construction, the bridge will be turned over to the people of the two states.

The opening of the bridge to traffic will take place on October 24th, with appropriate ceremonies led by Vice-President Curtis and the Governors of the two states. Construction on the bridge and approaches will continue after that date, less than 90% of the entire work being now complete. Eventually the architectural beauty of the structure will be enhanced by casing the steel towers in granite.

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SINCE 1878
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STANDARD BY WHICH QUALITY IS JUDGED
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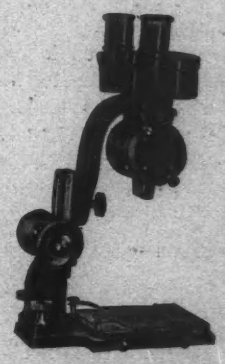
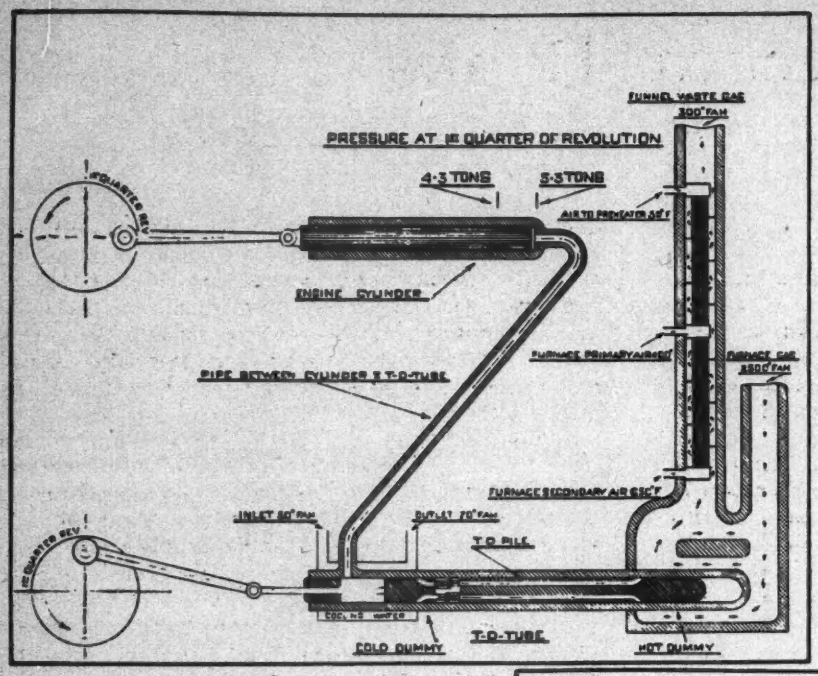


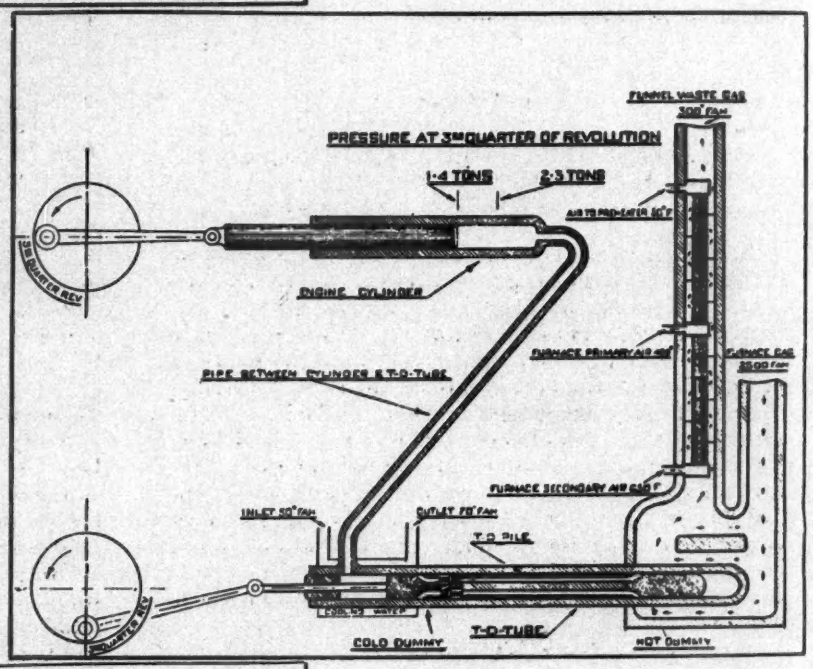
BAUSCH & LOMB
OPTICAL COMPANY
ROCHESTER NEW YORK

Water Expansion Engine

(*See page 165*)

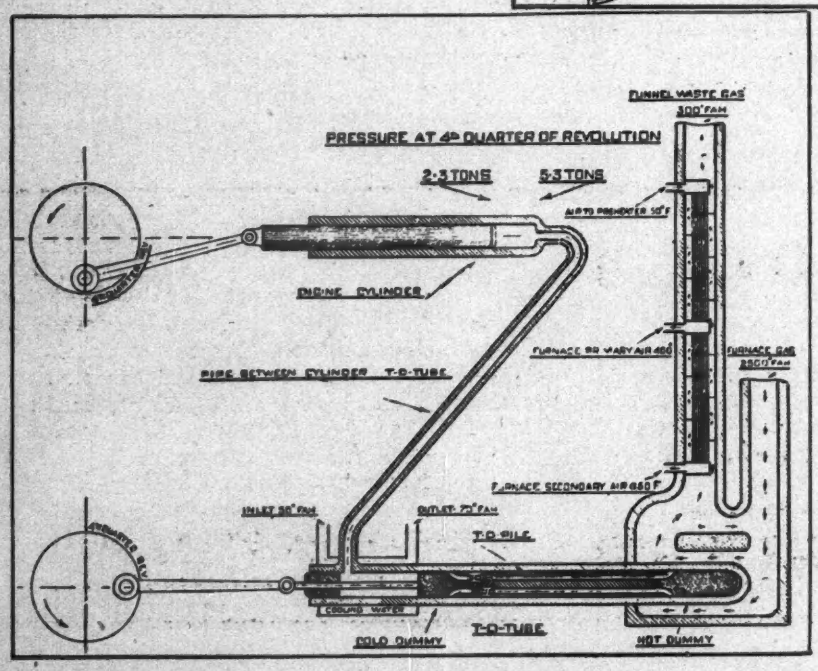


First Quarter Revolution. The "TD" is at Half-stroke moving toward cold end.



Third Quarter Revolution. Power plunger at full stroke. "TD pile" approaching hot end. An engine of this type will run smoothly ten minutes after lighting furnace.

Courtesy Power



Fourth Quarter Revolution. Completion of cycle, with "TD" at hot end of cylinder

Recent Books

(*Continued from page 166*)

switchboards and motors are next presented to complete the discussion of the machines and devices which are used in the electric system. The discussion of the component parts of the electric system begins at its source, the generating stations, and proceeds logically through transmission and substations to distribution. A general discussion on protection of electrical apparatus, circuits and systems is given, and inspection and maintenance of electrical equipment is covered in detail. Numerous illustrations, diagrams, charts, engineering tables and definitions of electrical words and terms help to make this a thorough and valuable manual on this important branch of electricity. Higher mathematics is omitted and all technical expressions are fully explained, so that the book is above all practical. It is valuable for the information it gives as to the authentic data and the up-to-date methods as used by the biggest electric light and power companies.

J. R. M.

MAGAZINE MAKING. By John Bakeless. The Viking Press, Publishers, New York City. 323 pages, illustrated, with index. Price $3.00.

For those who read magazines, and for those who edit and publish them, John Bakeless, of the Department of Journalism of New York University, has written a comprehensive summary of the fine art of Magazine Making. Mr. Bakeless's wide experience in the editing of national journals has fitted him to write with an intimacy which lightens the book for the general reader and inspires confidence for the amateur publisher who is interested in sound publication practice. Primarily designed for use in courses of journalism, the book fulfills the function of handbook for those whose vocation, or avocation, is magazine publication, and at the same time contains much information about the outstanding periodicals of the day of value to the casual reader.

The layout of the book is orderly, almost in the manner of Hudson's Manual. Beginning, logically enough, with a discussion of the economic basis of the magazine, the author then turns to a complete discussion of the organization of the magazine staff. The place of each member, Editor-in-chief to printer's devil, is clearly outlined, with special emphasis on the relations between individual staff members. The sore spot of publication, the relation between editor and printer, is dealt with in a special chapter which contains an unusually complete summary of the printing trade and its foibles, for the use of harassed editors.

Chapters on the solicitation and judging of manuscript, and the preparation of copy and proof, with helpful advice on the problem of getting along with authors make up the middle portion of the book. The business management of periodical publications, advertising, circulation, and publicity, also comes in for its share of attention.

Because of its convenient arrangement, it is possible for any member of a magazine staff to select the part of the book with which he is concerned and get the maximum amount of benefit without having to read the entire discussion, and an index provides the means for reference on a particular problem.

Magazine Making cannot be called simply a handbook, for the reason that the author has introduced a narrative style, so that for every type problem there are several examples taken from the publication practice of the great magazines of today. The book thus contains a wealth of interesting bits of information, from the true identity of S. S. Van Dine to the startling method of editing used by True Story Magazine, with quotations from such great men in publishing as Edward Bok and S. S. McClure to lend personal interest.

Mr. Bakeless makes particular mention of the Technology Review several times as an example of "quality" magazine with a professional circulation. Dean H. E. Lobdell, and Mr. J. R. Killian, present editor of the Review, read the manuscript of the book before its publication, and the author acknowledges their assistance in his preface.

Magazine Making is recommended not only to the staff members of publications who have particular problems to meet, but also to the general reader who will find in its pages the inside story of publication from which he can gain a fuller understanding of that great institution, the national magazine.

D. G. F.

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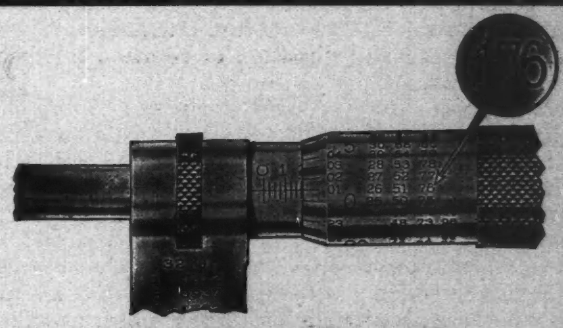

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TAPES and RULES

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106 LAFAYETTE STREET, NEW YORK CITY

Turbine Electric Ship Propulsion

(*Continued from page 161*)

purposes more advantageously.

The synchronous-induction type of motor possesses the characteristics of high efficiency and unity power factor but does not lend itself readily to the pole changing feature. It is also phased in at relatively low generator speeds (usually ¼ speed) and therefore does not lend itself so readily to installations in which auxiliary powering combinations are a requisite feature. The principal field of application of the synchronous-induction type of motor is on the large high powered passenger vessel, which operates continuously at or near its full power rating.

The flexibility of power arrangement on a turbine electric drive ship depends upon the number of main turbine generators installed and the number of propeller shafts.

Multiple-Screw Ships

In a twin screw ship with one main turbine generator, both propelling motors are operated in parallel and, therefore, at the same speed. In maneuvering, both propellers may be operated at the same speed either ahead or reverse, in opposite directions at the same speed, or singly in either direction with the other at standstill.

In a twin screw vessel with two main turbine generators installed, each main generator is electrically connected to one propelling motor under normal full power conditions. Both propelling motors can also be operated in parallel from either main turbine generator under reduced power conditions. The amount of power and speed that can be realized with one of the two main turbine generators only in operation depends upon the design of the turbine generating equipments. This point is usually decided after a thorough study of the powering needs of the vessel is made with respect to the given trade route and the schedule speeds between the various ports of call.

In maneuvering a twin screw vessel with both main generators in use, the propellers can be operated independently of each other at any speed or direction of rotation desired. When maneuvering under the one generator operating condition the same restrictions prevail as exist in the twin screw ship with one generator.

In a quadruple screwed ship with one propelling motor on each shaft and two main turbine generators, the two starboard motors are paralleled on one generator, and the two port motors on the other. At reduced power all four motors may be paralleled on either generator. In maneuvering with both generators in operation, the two motors on a side may be operated in speed and direction of rotation independent of the two motors on the other side. The two motors on a side, however, work at the same speed and in the same direction of rotation. Maneuvering under the one generator operating condition, the restrictions are the same as on a twin screw ship, except that the two motors on a side always work in unison.

A quadruple screw ship with four main generating equipments installed gives a great variety of combinations, whether there be one propelling motor attached to a shaft or two. Any one of the four generators can be used to furnish power to the four shafts at low powers. Any two of the generators may also be selected to drive the four shafts at intermediate powers by paralleling the two motors on a side. With three generators in operation the two inboard motors are paralleled on one generator and the outboard screws each operated from an individual generator. When operating with four generators, each generator furnishes power to an individual shaft.

Because of the great flexibility in powering arrange ment electric drive is also increasingly reliable. Over a wide range of loads it is also more economical because at reduced powers the turbine generators not in use also reduce the auxiliary powering requirements in proportion. The generating equipments on duty are also working on a more favorable power load, and, therefore, at a higher efficiency.

No Limits to Power

When applying turbine electric drive there are no limitations as to the amount of power that can be applied and studies have been completed for ship installations up to 300,000 shaft horsepower. Whether such powers will ever come into use, is problematical, although the high speed ocean liner of above 200,000 horsepower seems almost a certainty. The airplane carrier *Saratoga* developed upward of 215,000 horsepower on test, or nearly 54,000 horsepower per propeller shaft.

From the standpoint of operation, turbine electric drive has many advantages. Maneuvering is accomplished by switching the connections and not the direction of rotation of the prime mover. This simplicity of operation also permits the turbine to be built in its simplest form and the same availability of power for backing as for going ahead. As there is no mechanical connection between the turbine generators and the propelling motors, the generating equipments can be installed where most convenient. It is general practice to mount the turbines directly above their respective condensers, thus making the turbines self-draining and doing away with long overhead exhaust casings.

Experience over a long period of years has demonstrated that the licensed steam engineer is perfectly capable of handling the equipment and up to the present time this has been the only type of engineer who has assumed charge of the equipment. The operating control gear is made very simple and the levers are so interlocked that no error can be made in the sequence of operations. There are three levers for maneuvering the vessel—the turbine speed lever, the field lever and the reversing lever. When reversing a propeller the turbine speed lever is moved to its "slow" position, the field lever to the "off" position, and the reverse lever to its "astern" position. The field lever is then moved thru its various positions until the motor is in step, and then the propeller speed desired is attained by moving the turbine speed lever.

As a general rule, it takes an engineer only a few moments to master this sequence of operations and he quickly becomes very adept at it. The motors are held in step under different sea conditions by altering the voltage of the system to meet the conditions. This is quickly accomplished by varying the excitation, and an excitation indicator is situated on the panel which tells the engineer the proper amount to carry.

In conclusion it may be said that turbine electric drive as now being developed for the modern pas-

senger liner ushers in a new era of marine engineering. It accommodates itself safely to high steam temperatures and pressures, to steam extraction methods of feed water heating, and to a degree of flexibility in installation and powering combinations unattainable with any other form of drive. The modern electric liners that are now being added to our fast growing merchant marine are all distinctive ships of which America may be proud, for they typify an engineering development born in this country.

Models of the Mississippi River and the surrounding territory are being used by the Mississippi River Commission in the study of flood conditions. The effect of levees, dams, etc., can so be thoroughly studied and tested before going to the expense of construction.

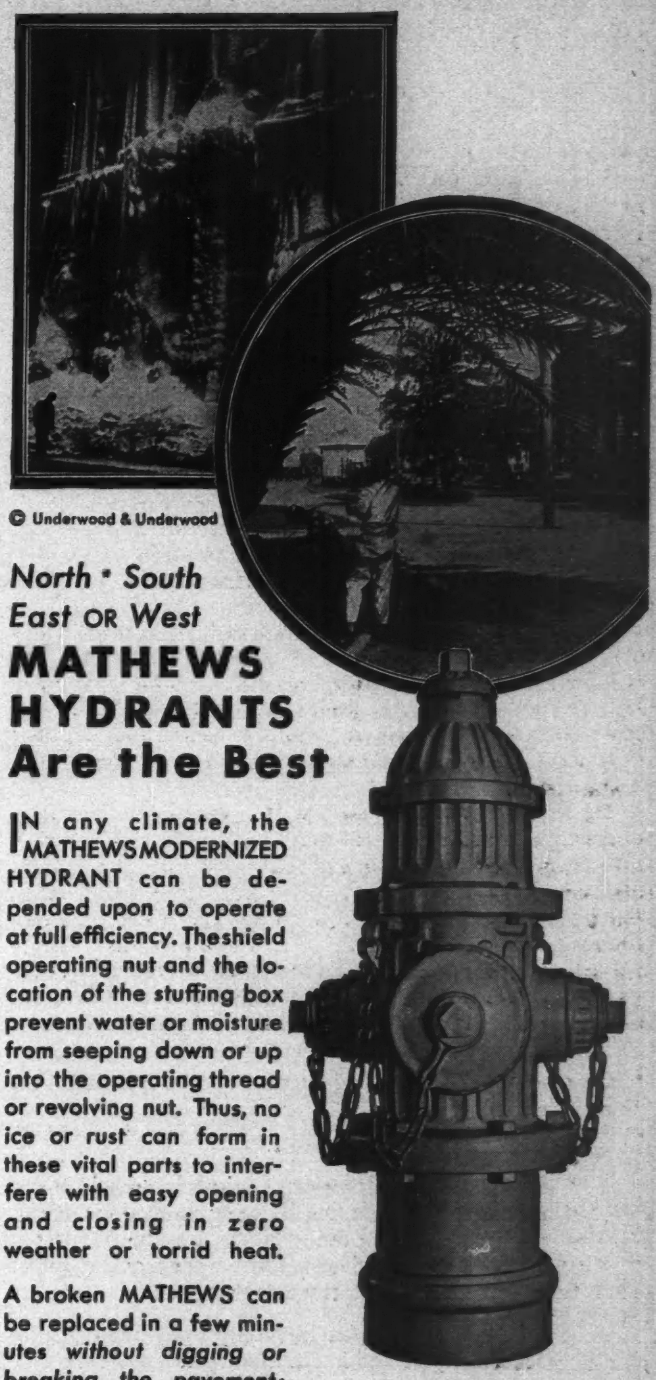
A typical model is that of the Greenville bend which includes 98 miles of river extending below the mouth of the Arkansas River. A model of this territory was built to a horizontal scale of 1:4800 and a vertical scale of 1:360. After several experiments the model was finally constructed of concrete with gravel carefully placed to make the streamlines correspond to those actually observed in the river. Water was then run through the model and observations taken of the flowlines and of the various depths of water. By controlling the amount of water entering the model it was quite easy to simulate any imaginable condition of flood. Various cutoffs were tried and the results tabulated. From this series of tests the best method of controlling the actual river will probably be derived.

Over a series of tests the model was found to be very accurate, the actual results differing from calculated results in some cases by less than 1%. To aid in observation dyes and threads were inserted in the water to indicate flow lines and eddies of all sorts. In addition to the model of this section of the river models of several other sections have been made.

A Giant Wind Tunnel capable of testing a full sized airplane has been completed at Langley Field. The tunnel is in the form of a large, flattened figure eight. At the center of the figure a break in the channel walls are made and a space 30 feet high and 60 feet wide provided. The airplane to be tested is then mounted on a floating platform, being held in position by means of hinged tubular struts. By means of these struts the forces on the airplane are transmitted to six balances below the plane which measure the forces of lift, drag, and transverse force and the pitching, rolling, and yawing moments. All measurements by the balances are automatic and simultaneous and are recorded by the machines on small cards.

The plane is, naturally, mounted directly in the path of the wind-stream. It is in an open space between the mouths of the two tunnel sections but the tunnel mouths are so designed that an even flow of air is maintained by the plane. When in test the plane is actually flying under its own power into the air-stream.

The air is propelled through the tunnel at a maximum speed of 115 miles per hour by two 34 foot propellers. Each of these is driven by a 4000 horsepower electric motor. The air is carefully smoothed out as in smaller tunnels by vanes in the tunnel. The advantage of such a large and expensive tunnel is that the designer does not have to take into account the so-called "scale effect" which is present on models tested in a wind tunnel.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IN any climate, the MATHEWS MODERNIZED HYDRANT can be depended upon to operate at full efficiency. The shield operating nut and the location of the stuffing box prevent water or moisture from seeping down or up into the operating thread or revolving nut. Thus, no ice or rust can form in these vital parts to interfere with easy opening and closing in zero weather or torrid heat.

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Established In 1803

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CHEMICAL ENGINEERING PRACTICE
CHEMISTRY
CIVIL ENGINEERING
ELECTRICAL ENGINEERING
ELECTROCHEMICAL ENGINEERING
GENERAL SCIENCE
GENERAL ENGINEERING
GEOLOGY
INDUSTRIAL BIOLOGY
MATHEMATICS
MECHANICAL ENGINEERING
METALLURGY
MILITARY ENGINEERING
MINING ENGINEERING
NAVAL ARCHITECTURE AND MARINE ENGINEERING
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Graduates of colleges or of scientific schools of collegiate grade, and in general all applicants presenting satisfactory certificates showing work done at another college corresponding approximately to at least one year's work at the Institute, are admitted to such advanced standing as is warranted by their previous training, and are given credit for our required subjects, including the entrance requirements, so far as they have been satisfactorily completed.

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PREVIEW

IN "Atomic Theory—1931," Professor Langer, last year a member of the Physics Department staff at Technology, has written a lucid exposition of that difficult subject, the present status of the electron and the atom in the eyes of the physicist. Dr. Langer gained his early training at California Institute of Technology; he has had training at the Bureau of Standards, and is now professorial lecturer at University of Minnesota.

FIRE alarms were once spread by the unaided human voice. How the engineer has since contributed his ideas until automatic telephone systems have been successfully used for the same purpose, is well told in the article by Professor Schwarz, of the Mechanical Engineering Department. Even the populace of Boston, it appears, was unable to count to 26 correctly when turning in an alarm required turning a crank that many times—no more no less.

"THE Transatlantic Liner 1819-1931" is, as might be surmised, a history of the floating hotel. Robert Macy, a junior in Naval Architecture, has written the story from the time when sails helped a side wheeler to cross in thirty-five days to the four and one half days now consumed by the *Europa*. The $125,000,000 to be spent in Great Britain and America for the accomodation of the *Princess Elizabeth*, to be launched in 1933, will be "a very considerable blow against the depression and unemployment."

THE coming of electricity to the steam railroad is symbolized in the title "Copper in the Iron Horse." J. V. B. Duer, Electrical Engineer of the Pennsylvania Railroad, describes the problems which have beset him in the conversion of 2210 track miles from steam to electricity. When the present project is complete, the greatest electrification in the world will have become an operating unit; but not without problems of major magnitude having first been solved.

WHEN the first integraph was developed at Technology some years ago, the Associated Press thought it worthy of a news dispatch. The new photoelectric integraph has arrived, developed in a doctor's thesis by Truman S. Gray '28, now in charge of the new gaseous conduction (radio tube building) laboratory of Course VI. The article, written by Albert Dietz '31, chief of T. E. N.'s editorial board, has been authorized by Dr. Gray.

WITH this issue begins a new feature, the "Engineering Digest." Originally suggested by the success of the *Reader's Digest*, this feature is a regular monthly department. Condensations of the articles which every engineer wants to read, but does not for lack of time, will appear, published by special permission of the original publishers.

BODONI, the name of a type face, characterizes the type with which this issue is printed. The same face is used throughout the editorial content; headlines, body type, captions. It is dignified and more readable; hence the change from the Scotch Roman used in previous issues.